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ELECTRICAL WORLD AND ENGINEER.

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THE FRITZ MEDAL.

The manner in which the four national engineering societies have co-operated, with notable success, to endow and celebrate the foundation of the John Fritz Medal, is of the best augury for further federal work for the best interests of the professions represented. The prompt participation of members of the American Institute of Electrical Engineers in both the medal fund and the birthday banquet, has been to us a matter of great satisfaction, while we know that it has also been regarded with pleased surprise by the members of other societies with which Mr. John Fritz has been in closer relation. It is natural that in alliances of this kind there should be some jealousies, rivalries for precedence among the bodies, and possibly a little suspicion of the other fellow's altruism. But all these are but symptoms of devotion to one's own worthy cause, and we believe that when such enthusiasts do get together and learn to trust and work with each other the result aimed at is reached all the more quickly. After all is said and done, the work of such bodies will always be accomplished by a few devoted, single-minded men, but it surely strengthens their hands and their resolution, to find in kindred societies, men of like sentiments and impulses with themselves, with practically the same lofty, disinterested ends in view.

This Fritz medal, so worthily bestowed, ought to be regarded as a bond and pledge of work in other directions. We might mention one, namely, the securing of a commodious engineering building in this city, to accommodate the headquarters of the various societies of an engineering and scientific character, and to house also the engineers' Club, which has long been the hearth and social rallying point of all such institutions. There need be no surrendering of autonomy by any society; there need be nothing eleemosynary about the plan; but it does seem to us that this is a cause which should appeal for financial support to the superabundant wealth placed by the skill and labor of engineers in generous hands. The American Institute of Electrical Engineers is very badly in need of a home for itself and its matchless select library, and we sometimes wonder there is not a rush of electrical millionaires to fill the want and to cover themselves with praise and glory. We have despaired long time of the joint engineering building, but make bold to say that the man who meets these pressing necessities will do more for the arts and sciences than if he added another to the already redundant colleges and universities.

MORE WIRELESS PUZZLES.

A report last week chronicles the troubles experienced in the use of wireless telegraphy during the recent British naval manœuvres in the Mediterranean. We can hardly score it as a failure of wireless telegraphy, technically considered, since the chief source of woe was that the transmission worked so well as to hopelessly mix up the messages of friend and foe. Wholesale interference with messages is almost as serious and fully as annoying as inability to send any messages at all. The attacking squadrons are reported as totally unable to make effective use of their wireless outfits by reason of the persistence of the defense in sending confusing messages. We know not what was the substance of these, but the senders of them would have been more than human if they had been unremittingly polite.

Fancy the wrath of an admiral commanding, at having miscellaneous objurgations and selected personalities hurled at him out of ionized space! His case would be little better than that of Lieutenant General Bangs, immortalized in Kipling's verse, with the added sorrow of being unable to locate the offender against official dignity. For the last year or two we have been hearing much of so-called syntonized systems, but in spite of the number of times the problem has been solved in the newspapers, the net result has evidently not made its début in the British navy. We fear this branch of electricity "is still in its infancy" so far as military operations are concerned. And unless we are very short of memory, the wireless system attempted during our own combined military and naval manœuvres left several things—including messages—to be desired. It is quite certain that wireless telegraphy is capable of doing important work in the world, but just now there seems to be great need of investigating its limitations and getting a line on its practical field of usefulness. This matter of mutual interference is a serious one, and it cannot lightly be put aside by invoking a syntonized system unless said system is demonstrably effective. And even granting a perfected syntonized system, it still remains to insure its operation in face of persistent and skillful attempts at interruption. Could not Marconi beat his own game, especially now that he is said to be sending not merely single letters but full-length messages across the Atlantic?

The Valtellina Railway.

A short time since we noted the formal opening of this most interesting line, and last week were enabled to present to our readers some important details of the installation to which we desire to make further reference. Perhaps the most striking feature of the transmission system from which the railway derives its power is the fact that the generators are wound to give 21,000 volts directly from their stationary armatures. This, if we mistake not, is the highest generator voltage yet attempted on a commercial scale. In this country little more than half this pressure measures the capacity of most of the high-voltage generators. Yet there seems to be no good reason why 12,000 or 15,000 volts should be the limit thus reached. Experience has already shown that stationary armatures are easy to insulate, and with the experience that has been gained in the construction of transformers, a 20,000-volt generator should present no serious difficulties. From the present outlook, the upper limit of line voltage is receding into indeterminate distance, and it would be nothing surprising if the present usual line voltages were doubled in the next decade. When one goes in for high voltage he might as well be hanged for an old sheep as a lamb.

Another point not generally taken into account in considering this Valtellina line is the great additional difficulty introduced by having to work over a line originally planned for steam locomotives, without any cessation of the steam service during the period of construction and experimentation. This is a very different proposition from starting out in a fresh field, and the successful result is, therefore, doubly worthy of commendation. Of course, such a system as this cannot be regarded as a finality in traction by alternating-current motors, for there are still difficulties to be overcome and there is much yet to be learned in the operation of alternating motors for railway purposes. But in some form or other the high-voltage working conductor is the key to the situation, and every experiment, be it success or failure, adds to the common stock of knowledge. Ganz & Co. deserve the greatest credit for their persistence in the face of many discouraging conditions, not the least trying of which was the attitude of the Italian government.

Engineering.

Professor John Perry's opening address to Section G of the British Association is a very amusing and interesting discourse. It is amusing for its combativeness of existing methods and institutions. It is interesting for the breadth and candor of its views. As Herbert Spencer long ago pointed out, ornament precedes utility in the history of all superfluous acquisitions. Ornamentation took the lead over usefulness in the early development of apparel, liberal arts and education. Although utility now occupies the first consideration in all these directions, yet the evidences of the reign of adornment are clearly visible. In general education, undue prominence in ornamental studies evidence a survival of the unfit. There is something intensely grotesque in a busy practical age like ours spending a large part of several of the best years of a boy's educational life in teaching him Latin and Greek, languages which he will never attempt to speak, and which he will probably never read in later years. The educational value of Latin and Greek are unquestionable, but it is no greater than that of French and German. The beauty and the importance, in history, or in literature, of Latin and Greek are undoubted. But the study of these subjects should continue to be the devotion of the few, not the burden of the many. From a modern curriculum ancient things should be removed. In another way this spirit of conservatism is carried even to greater grotesqueness in our navy through the official policy which requires that those who are to man the mastless aggregations of machinery constituting the modern war vessel, shall be trained on sailing vessels. The selection of the trireme instead would have been but a short step to a reductio ad absurdum.

Professor Perry takes up the cudgels in favor of a utilitarian method of educating utilitarians, and of engineering methods of teaching engineering students. He condemns the existing school system of Great Britain in terse and fearless language. He is probably right. The average school, not only in England but also in every civilized country, attempts to carry education over too many subjects to give adequate development in the essentials for commencing an engineering course. The result is apt to be that the first year of a collegiate course in a technical college is spent by the student in acquiring familiarity with those principles which should have been completely within his grasp on entering college. Nevertheless, the tendency is always towards improvement. Latin and Greek are now relegated more and more to innocuous desuetude. The average school is every year tending to eliminate from its courses what is unnecessary, and to teach what is practically useful. Professor Perry's millennium in technical education is certainly remote, but its dawn is here. His labors to advance the epoch are timely and in some measure, we trust, effectual.

Integrating Photometers.

The paper of Prof. C. P. Matthews, read at the last meeting of the American Institute of Electrical Engineers, and reprinted elsewhere in this issue, calls renewed attention to the desirability of measuring the mean spherical candle-power of an incandescent lamp, or what is virtually equivalent thereto, the total flux of light it emits. The customary method of comparing luminous sources wholly on the basis of mean horizontal candle-power is as faulty as would be the plan of comparing the sizes of casks by exclusive reference to their girth at the middle, and entirely ignoring their relative heights. In the past the difficulty of measuring the spherical candle-power of incandescent lamps has been largely responsible for the sole reliance on horizontal candle-power. Moreover, lamps having similar geometrical forms of globe and filament are known to give a total flux of light approximately in porportion to the mean horizontal candle-power. Variations in the shape and arrangement of the filament are,

however, likely to bring about variations in the luminous distribution, such that if operated at the same mean horizontal candle-power per watt, one type of lamp will be worked harder, and be shortened in life, relatively to the more favored type.

The apparatus described by Professor Matthews promises to give one more practical means of measuring the total flux emission of an incandescent lamp at a single observation, and its practical success will remove the excuse that it is not possible to make the measurement. There are now at least three types of photometer constructed by which mean spherical candle-power may be measured at a single observation. In practice it is only necessary to determine the mean factor of reduction from horizontal to spherical for a limited number of lamps of the same structural type, and for most purposes this factor of reduction can be applied to the horizontal candle-power of all lamps of this type; so that in the observation of lamps in commercial photometry the mean horizontal candle-power, as usual, needs only to be measured, the reduction to spherical being computed when so desired by the use of the reduction factor for that particular structural type of lamp. Prof. Matthews's paper is a valuable one from various standpoints of photometry.

The paper read by Dr. C. H. Sharp at the same meeting goes to show that under practical conditions of photometric measurement, incandescent lamps can be compared for horizontal candle-power within a mean deviation of about half one per cent.; while secondary standard lamps can be compared within much smaller limits of deviation, by taking more care with the measurements. The photometer accuracy under such conditions narrows down to a range which is scarcely greater than that of standard voltmeter accuracy. Such a degree of accuracy in photometric measurements is, however, only possible in lamps which have the same color. When the lamps, or luminous sources, compared differ considerably in color, the probable error of the observation increases for one and the same observer, while it increases still more rapidly with reference to a group of different observers. This is why a primary standard of light in the form of an incandescent lamp constructed under rigid and reproducible conditions would be so valuable if it could be made reliable. Up to the present, however, the limits of variation in the light-emissions of incandescent lamps, manufactured as nearly as possible under the same conditions, appear too great to promise success in devising a standard incandescent lamp as a definitely reproducible luminous source.

POWER IN MANUFACTURES.

One of the most interesting of the reports issued by the U. S. Census Office, coming naturally at the close of the statistics on manufacturing, as a "round up" of the data developed, is the Bulletin No. 247, devoted to the power employed in manufactures, metal working machinery and motive power appliances. This report has been compiled and arranged by Messrs. E. H. Sanborn and T. C. Martin, both of whom were employed on other parts of the inquiry into manufacturing, etc., conducted under the able and vigilant direction of Mr. S. N. D. North, the chief statistician. The amount of data and material developed is indeed surprisingly large, and some idea of the extent of the ground covered may be learned from the fact that no fewer than 512,254 establishments came under consideration. Perhaps the extent to which hand power is still resorted to, evidencing the opportunity for small electric motors, may also be gauged from the singular fact that of these half million establishments only 169,409 reported power. In other words, in only 33 per cent. of the "shops" in the United States does it pay to instal ordinary mechanical power, or a gain of about 5 per cent. in ten years. While in this age of combination and trusts we have thus at once a significant demonstration of the prevalence and preponderance of hand power in scattered, individual shops and factories, the old argument for electric power comes back with renewed and irresistible cogency, for if ever such establishments are to be aided by other than mere brute, human energies, electricity is the means for relieving them. No other agency can begin to compare with it for ease, simplicity, flexibility and economy in the cheap distribution of small power to innumerable minor concerns.

Steam continues, of course, to be the great primary power, and has risen rapidly, being as the report shows not less than 8,742,416 horse-power in 1900 out of a total of 11,300,081 horse-power. This is 77.4 per cent., whereas in 1890 it was only 51.8 per cent. Water power, on the other hand, has gone off, for although it has risen in bulk from 1,255,206 horse-power to 1,727,258, the percentage of the total in 1900 was only 15.3, as compared with 21.1 in 1890. But while this may be true as to manufacturing, it is hardly a true test of the relative position of water power development, unless it should prove that in lighting and railway work, steam has also shot ahead. There is a general impression that in electrical work generally, and in power transmission, water power has been able to redress the balance a bit. Some of the hydro-electric plants, as at Niagara, Massena, Sault Ste. Marie, etc., have been on a huge scale, but then again equally huge, and possibly more numerous, have been such steam plants as those of the New York Edison Company, on the East River, and those of the Metropolitan and Manhattan Elevated systems. There is little question, however, even taking these figures of manufacture, that water power would relatively have fallen off much more had it not been for electrical transmission, such as is seen in New England and the South, to factories of all kinds.

Not being a prime mover, it goes without saying that every time an electrical transmission is put in, the figures of steam or hydraulic generating plant are to that extent increased, offsetting the figures of the motors utilizing the current. This will, to some degree, explain the curiously disappointing figures of electric power, for it appears that electric power owned and rented for manufacturing work is only about 4 per cent. of the total, the figures being 311,016 hp owned, in 16,923 motors; and 183,682 hp rented. But what a magnificent margin to work on this leaves! Even as it is, it shows a gain of 1897 per cent. over the figures of 1890, when the electric motor had not fairly come in. It is encouraging to think of the field yet to be exploited. Moreover, the happy fact emerges, supporting theory, that while electric power rented is 183,682 hp, all other power rented is only 137,369 hp. It is obviously so easy to run wires and hire current; but it is not very feasible in most cases to extend shafting and steam piping from one establishment to another. In the early days of the motor, it was proposed to rent out the motors as a means of introducing them, and the practice gained considerable vogue; but as the above statistics show, people now buy and own their motors, and the companies are not burdened with an investment it would have been extremely difficult to maintain free from enormous risk of detriment and depreciation. What this would have meant may be inferred from the statement that in 1900-1 the New York Edison Company reported 50,634 hp of motors connected to its circuits, or 30 times as much as in 1890. At $75 per horse-power, this would imply an investment by the company of nearly four millions in machinery that it would have had to watch with inspectors over widely scattered territory. And, obviously, the plan of selling motors outright has not checked their adoption, in view of such phenomenal increases.

John Fritz Medal Foundation and Celebration.

The name of John Fritz, the great American ironmaster and mechanical engineer has long been associated with brilliant successes, and the foundation of the medal in his honor as well as the birthday dinner to celebrate it are certainly worthy to be called great successes also. The various stages in the affair have been noted in these pages, but may fittingly be recapitulated here. Last spring, at the call of Mr. S. T. Wellman, of Cleveland, a number of engineers and manufacturers met in this city to discuss the question of a suitable celebration of Mr. Fritz's eightieth birthday, the outcome of these meetings being the appointment of the following general committee:

President, S. T. Wellman, Wellman-Seaver Engineering Company, Cleveland, Ohio; treasurer, John Thomson, New York; secretary, C. Kirchhoff, editor *The Iron Age*, New York; S. W. Baldwin, Pennsylvania Steel Company, New York; N. H. Heft, New York, New Haven and Hartford Railroad, New Haven, Conn; R. W. Hunt, Chicago, Ill.; F. R. Hutton, secretary American Society of Mechanical Engineers, New York; C. Warren Hunt, secretary American Society of Civil Engineers, New York; J. C. Kafer, president The Engineers' Club, New York; T. C. Martin, editor the ELECTRICAL WORLD AND ENGINEER, New York; E. E. Olcott, president American Institute Mining Engineers, New York; R. W. Pope, secretary American Institute of Electrical Engineers, 26 Cortlandt Street, New York; H. G. Prout, editor the *Railroad Gazette*, New York; E. G. Spilsbury, New York; Jesse M. Smith, New York; Ambrose Swasey, Cleveland, Ohio; Oliver Williams, Catasauqua, Pa.; Calvin W. Rice, New York; Wm. Maver, Jr., New York.

The organization was effected by the appointment of four sub-committees, as follows: Medal Committee—C. Warren Hunt, chairman; F. R. Hutton, R. W. Pope, C. Kirchhoff. Finance Committee—John Thomson, chairman; Ambrose Swasey, Jesse M. Smith, E. E. Olcott. Dinner Committee—T. C. Martin, chairman; J. C. Kafer, H. G. Prout, E. G. Spilsbury. Invitation Committee—S. W. Baldwin, chairman; N. H. Heft, R. W. Hunt, Oliver Williams.

Various rules were adopted to govern the foundation of a John Fritz medal, the design of which was happily entrusted to Mr. Victor D. Brenner, a well-known medailleur.

Towards this medal the sum of about $6,000 was contributed by some 484 persons, including these from the electrical ranks: B. J. Arnold, E. G. Acheson, C. Batchelor, A. E. Brown, C. L. Buckingham, F. H. Ball, J. Barre, N. F. Brady, A. N. Brady, W E. Baker, C. A. Coffin, G. H. Day, J. M. Dodge, G S. Dunn, C. H. Davis, R. N. Dyer, T. A. Edison, W. L. R. Emmet, H. Eames, Eugene Griffin, N. H. Heft, G. A. Hamilton, F. B. Herzog, C. T. Hutchinson, F. V. Henshaw, J. D. Hawks, C. E. Hewitt, D. L. Hough, W. J. Johnston, W. C. Kerr, N. S. Keith, R. T. Lozier, J. W. Lieb, Jr., R. D. Lillibridge, J. Markle, T. C. Martin, W. McFarland, J. H. McGraw, F. A. C. Perrine, C. G. Roebling, F. W. Roebling, Calvin W. Rice, A. F. Sever, Elihu Thomson, N. Tesla, G. Westinghouse, Jr., B. H. Warren, J. Wetzler, W. H. Wallace, H. H. Westinghouse. There are some curious omissions from this list of those who might be expected to share in this movement, but the responses were so prompt, the lists were closed at a very early stage. Most of those named above were also participants in the banquet at the Waldorf-Astoria on October 31, which is said by competent observers to have been the finest gathering of engineers and leaders in the great metal industries ever seen in this country. The representatives named for the American Institute of Electrical Engineers on the medal council are the present president and the three latest past presidents, viz., Messrs. Scott, Hering, Steinmetz and Kennelly. Each president as he becomes a past president joins this body, succeeding the oldest past president on it.

The banquet was held in the ballroom of the Waldorf-Astoria, was a brilliant affair, being attended by 535 guests, of whom 125 were ladies, seated in the boxes, where light refreshments were served them. There were various features of novelty and suggestiveness. Over the banquet table was a fine electric sign, furnished by the Elblight Company, which flashed into light exactly as Mr. Fritz took his place under it. It read: "John Fritz, 1822-1902." Each end of the table were fine large models of blast furnaces, etc., loaned by the Stevens Institute of Technology, one of them, an open hearth, being realistically lit by red incandescent lamps to give the glow. On the table were tracks and hot metal cars, etc. The menu was made up in the form of embossed tin-plate, showing on the front cover a blast furnace in operation, and held together by real bolts as well as by ribbon attached to a small oxidized copy of the obverse of the medal. The sorbet was served in imitation sections of steel rail, little boxes with removable cover being fitted into the head. The ice creams were brought in in procession, headed by large candy models of the Westinghouse units at the Manhattan elevated plant; the "Oregon" battleship, a modern steel bridge, a big rifled gun, the famous new "Flatiron" building, etc., to exemplify the creations of the modern iron and steel industry.

Col. H. G. Prout presided most admirably as toastmaster. Among the speakers were Brig.-Gen. Eugene Griffin, U. S. A., for the Army, and Prof. Elihu Thomson, for the American Institute of Electrical Engineers, whose president, Mr. C. F. Scott, also sat at the speakers' table. The proceedings included the presentation by Mr. John Thomson to Mr. Fritz of a magnificent album containing the record of the medal fund and the autographs of all the contributors, and of a large bronze replica of the medal, the only one to be made, the casts being broken there and then. During the evening, also, Mr. John C. Kafer presented a superb hammered silver loving cup to Mr. Fritz, in the name of Mr. Irving M. Scott, the builder of the "Oregon." In addition to the excellent speeches, there were read a number of special congratulatory cablegrams from Andrew Carnegie and C. M. Schwab, and from leading ironmasters and engineers in England, Wales, Scotland, Belgium, France, Germany, Austria and Japan.

OBVERSE AND REVERSE—JOHN FRITZ MEDAL.

The medal shown above is 2½ in plane diameter, less 1/39 inch. Its thickness may be ⅛ inch, and it is to be struck in pure gold, 1,000 fine. The bronze cast given to Mr. Fritz is 7 inches in diameter. In bringing up the Fritz medal, it will require about six pressures of 250 to 300 tons each time.

As already noted in these columns the medal is to be awarded not oftener than once a year for achievement in the industrial arts and sciences. The four national engineering societies are each asked to name four representatives to constitute a medal Board of Award, and should any society fail in this, the others are to proceed to action. The medal is not limited to any part of the world, but is open to both sexes and every nationality. It is the first American medal that can compare for importance with the Bessemer.

The Opening of the Water Works Power Plant at Sault Ste. Marie, Michigan.

AT noon, October 25, occurred the formal opening of the water-power plant of the Michigan Lake Superior Power Company at Sault Ste Marie, Michigan. The event is an important one, not only to the citizens of that locality, but to the electrical industry in general, because it marks the beginning of operation of the second largest water power electric plant in this country. Many of the more important features of the hydraulic installation at this place were described in these columns September 27, 1902, so that but a brief mention of these need be made here.

It is notable that both of America's greatest water power electric generating stations (Niagara and the Soo) should derive power from the waters of our great lakes, and the two falls where water power is available, formerly given consideration in a practical way mainly because of the obstructions they offered to navigation, are now proving valuable assets in the wealth of the country through the water power developments made possible by their presence. Of the two falls, Niagara and the Soo, the former was naturally the first to attract sufficient favorable attention from capital to ensure their utilization. The result at Niagara has been the magnificent electric generating stations with which every electrical engineer is somewhat familiar. The rapids of the St. Mary's River being further from a market for power, with less available power and in a sparsely populated portion of the country, has been left for later development, but now that this development has taken place, it ranks in size among the leading power stations of the country, through not being as much of a pioneer plant in an engineering way as was the Niagara plant when installed, it lacks some of the engineering interest that accompanied some of the early Niagara work.

The Niagara plant was built with a large immediate market in view in the City of Buffalo, and also with the promise, which has since been realized, that a number of large industries requiring cheap electric power would cluster about Niagara. The Soo plant, on the other hand, has been built mainly on the faith that the future will bring to that point a market for the power which is now available, and that the existence of cheap power at that point will attract enough power consuming industries to utilize eventually the capacity of the plant.

The Michigan Lake Superior Power Company is but one of a group of corporations carrying on operations at the Soo, under the control of the Consolidated Lake Superior Company, which is under the general management of F. H. Clergue, a man of great enterprise and organizing ability. All of the various subsidiary companies except the Michigan Lake Superior Power Company are working on the Canadian side. There is a Canadian Soo water power, an electro-chemical company, a paper pulp mill, a machine shop, a blast furnace, a rolling mill, a railroad under construction to Hudson Bay, an iron mine, a ferro-nickel mine, a sawmill and numerous other incidental industries, operated under one syndicate. A history of how these enterprises came to be started one after the other by a sort of evolution of one from another makes an interesting story, but is aside from the purpose of this article.

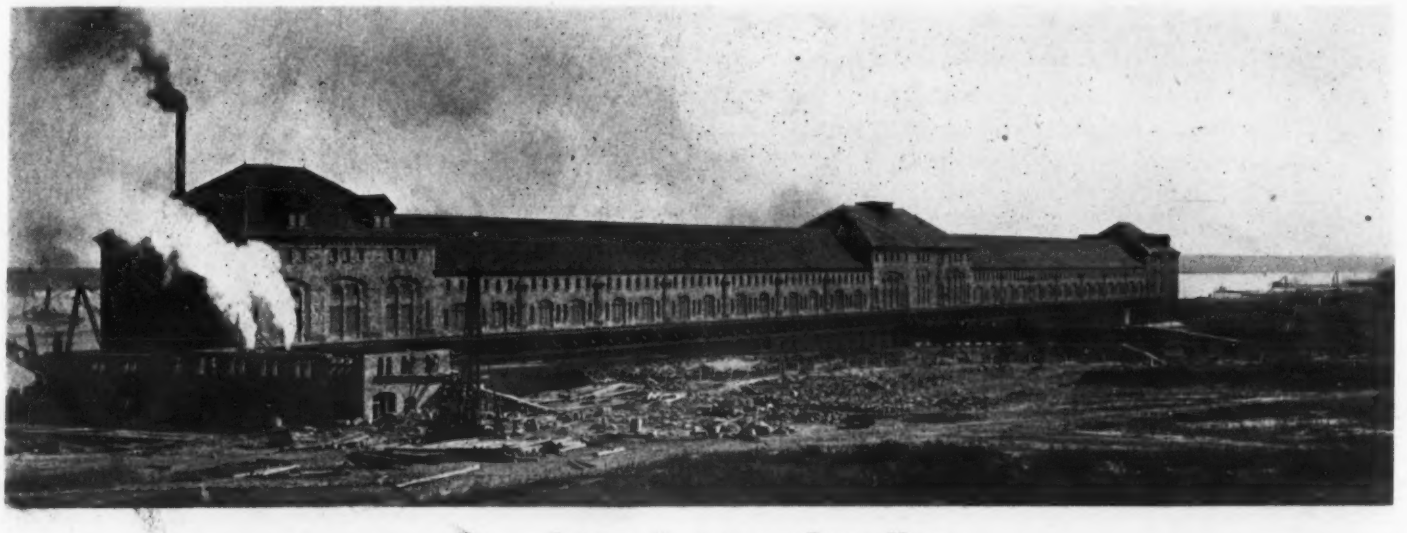


FIG. 1.—GENERAL VIEW OF THE POWER HOUSE.

No extravagant language is needed to convey to an engineer's mind the magnitude of this water power undertaking when, together with the accompanying photographs, the following figures are appreciated:

Length of canal from Lake Superior to power house on Ste. Marie River	13,000 ft.
Width of canal in solid rock	200 ft.
Depth of water in canal (average)	23 ft.
Length dam and power house	1,368 ft.
Number of generating units provided for	80
Size of units	400 kw
Head of water	17 to 21 ft.

Details of the hydraulic work can be found in the recent issue above referred to, together with a map showing the route of the canal through the town. A right of way 400 feet wide was purchased through the town for the canal. The power house, which also serves the purpose of a dam, is at the lower end of the canal fronting on the river, and the turbines discharge directly into the river.

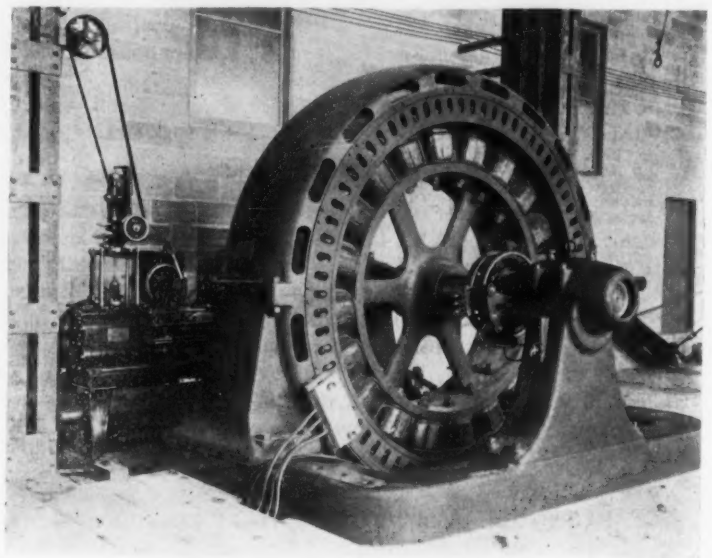


FIG. 2.—400-KW, THREE-PHASE, 2,400-VOLT, 30-CYCLE, 180 R. P. M., GENERATOR.

The canal and power house building are at present writing practically completed. Water wheels have been installed in more than half of the wheel pits, and four electric generators have been installed. Contracts for the electrical apparatus and installation are being carried out by the Stanley Electric Manufacturing Company, which company secured the contracts through the Michigan Electric Company, its Michigan agent, Mr. E. O. Sessions, construction engineer for the Stanley Electric Manufacturing Company, is in charge of his company's part of the work.

The water wheels were furnished by the Webster-Camp-Lane Company, of Akron, Ohio. There are four of these wheels in each unit, placed on a horizontal shaft, which shaft extends through a

water-tight joint in the bulkhead into the generator room, which is on the down-stream side of the power house. The turbine lies ordinarily submerged in water, and when in operation the four wheels discharge into one short central shaft tube. The gates for starting and stopping the wheels and for governing are located around the periphery of each turbine wheel. As the wheels are immersed directly in the water which drives them, and are not dependent upon columns of water confined in a pipe for supply, the governing can be very perfect, as there is so little trouble from the inertia of the moving column of water. The governing is to be by Lombard water wheel governors, and to vary the speed in order to obtain synchronism, electric motors controlled at the switchboard and changing the tension on the governor will be employed on the same principle as the synchronizing apparatus on steam engines. Six Stanley three-phase, 2,400-volt, 30-cycle alternators, to run at 180 r.p.m., are under contract, three of which have been installed. An old 60-cycle Westinghouse alternator has also been put on one of the wheels.

Mr. H. von Schon has been chief engineer of the undertaking. Mr. W. Owen Thomas is electrical engineer in charge of the electrical work, who designed many interesting electrical features to be described in a later issue.

At the present time the market for the company's electrical output is practically undeveloped but for one exception, mentioned later, and there is abundant power for industries desiring cheap electrical power to secure it at the Soo. The investment in the completed plant will be, it is announced, about $4,000,000, or $135 per kilowatt. This is not high as investments in water plants run, and the company ought to be able to make a very low rate. The exception referred to is the Union Carbide Company, which arranged before the power house was erected to take part of the building and output.

10,000-Volt Alternating-Current Locomotive.

ABOUT the time of the Zossen experiments we printed a description of the Siemens & Halske motor car used on the trials, written by the chief engineer of the company, Herr Walter Reichel. With this a speed of 96 miles per hour was repeatedly obtained, and on one occasion 99.5 miles. Owing to the insufficiency of the road-bed, higher speeds were not attempted.

The accompanying illustrations show a locomotive and some of its details, which has since been designed by Herr Reichel, and built by the same company, with the object to reduce weight. To this end transformers have been discarded and current supplied at the Zossen line voltage—10,000 volts direct to the motors. Instead of 96 tons, the new car weighs but 76 tons, including passengers, and the total horse-power has been reduced from 1,000 to about 920. The decrease in weight also facilitates starting.

For experimental purposes it was deemed advisable to build a locomotive rather than a motor car, and to employ gear to reduce the speed of the motors in the ratio of 2 : 1, the speed of the motors being 885 r. p. m. and that of the locomotive 100 kw per hour.

The underframe of the locomotive is of the double-truck construction, the axles and axle boxes being similar to those of the previous experimental car. The gauge is standard, and the wheels have a diameter of 49 inches (1,250 mm.) and conform in other respects with the standard dimensions of the Prussian State Railways. The wheel base of each bogey is 10 feet 8 inches (3¼ meters). Although only fitted with one motor each at present, there is room on each bogey for two. Fig. 4 is a general arrangement of the locomotive, with a pair of motors.

The design of the details of the motor are closely similar to those of motors for narrow-gauge track. It is necessary to make the utmost use of the space between the wheels, and the bearings are, therefore, placed within the space enclosed by the motor windings, as shown in Fig. 5. In order to keep the pressure on the two bearings equal, the motor shaft is geared at each end to the car axle, there being a narrow spur wheel at each end of the motor shaft instead of a wider one at one side only. Another reason for this arrangement is that not only the pressure on the teeth, but also the velocity of the teeth is exceptionally great. The latter amounts to about 59 feet (18 meters) per second, with 147 teeth in the larger wheel and 69 in the smaller wheel. The pitch is 1.41π inches (6π mm.), and the width of teeth 3.93 inches (100 mm.).

Previous to deciding on the system of lubrication, a number of experiments were tried with tooth velocities of 82 ft. (25 meters) per second. These demonstrated that it was not sufficient to fill the gear box with oil or grease and let the gear run in it, and consequently a system of forced lubrication with compressed air was adopted. By means of a pump, a pressure of air corresponding to 2 inches (5 cm.) of mercury is produced in the oil reservoir. This drives the oil out of the reservoir to a distributing cock, which is turned to the right or left according as the locomotive is to run for-

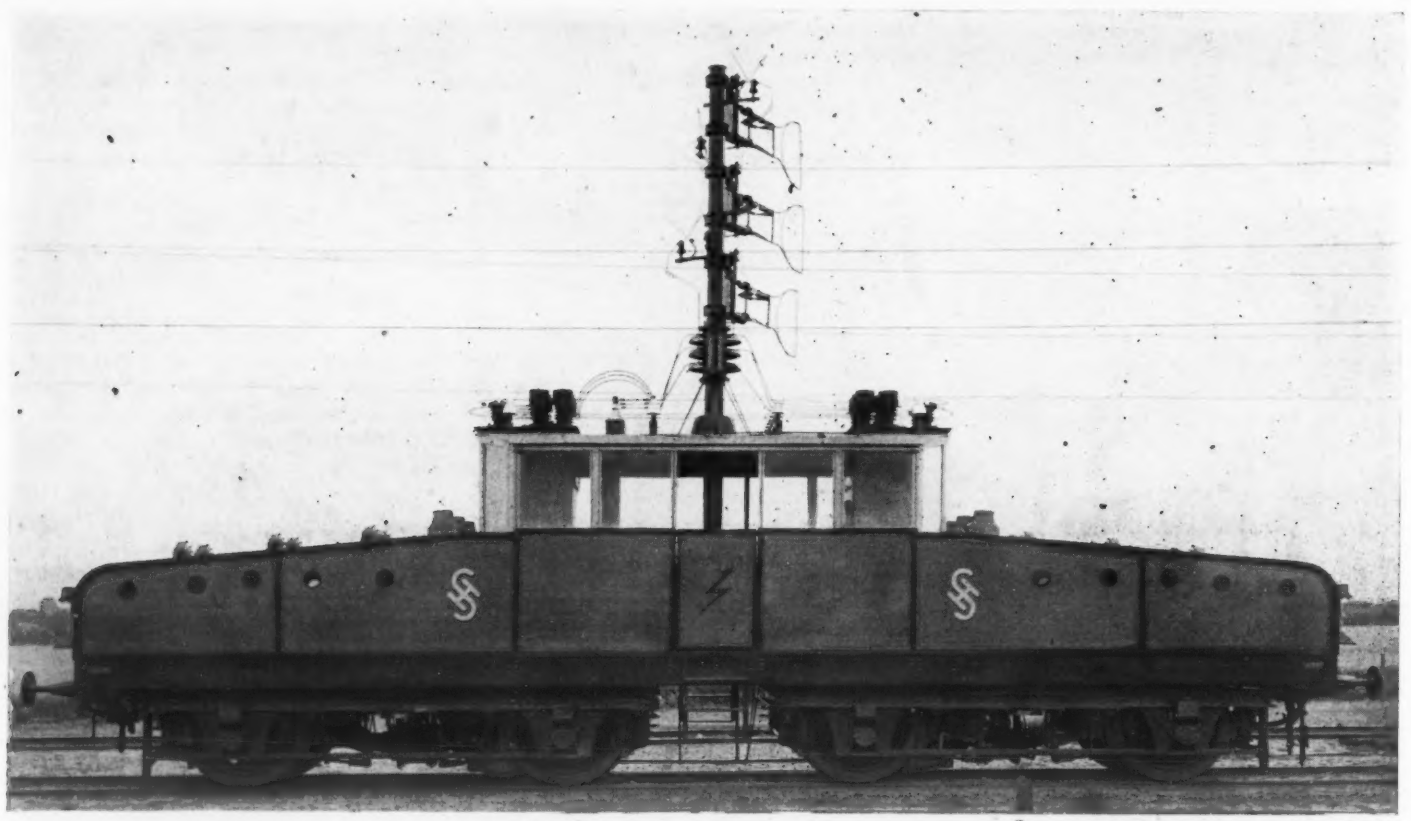


FIG. 1.—ALTERNATING-CURRENT LOCOMOTIVE.

wards or backwards. Thence the oil flows through one or other of two sets of pipes to the nozzles above or below the toothed wheel.

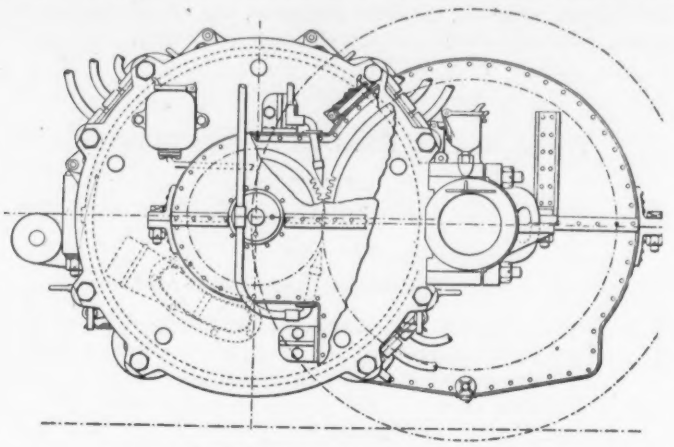


FIG. 2.—ELEVATION OF MOTOR AND GEAR CASE.

After the oil has been used, it collects at the bottom of the gear case, and is thence pumped by a hand or motor pump back to the oil reservoir. This system of lubrication is only necessary with a gear ratio of 2 : 1. If a ratio of from 1.35 to 1.4 is used, the velocities of the teeth are smaller, and the ordinary lubrication with grease is sufficient. The construction of the gear box is in other respects the ordinary one, as is also the suspension of the motor.

The motor case is of cast-steel, and is made in two parts. It is carefully turned inside—the internal diameter being 39 inches (990 mm.)—so that there is a firm bearing surface for the active iron, and a good conduction of heat through it. The bushes of the bearing are in one part, and of bronze lined with white metal. They are 11.8 inches (300 mm.) long and 3.9 inches (100 mm.) internal diameter, so that there should be little wear. This makes it possible to reduce the air-gap of the motor to 5/64 inch (2 mm.). The active iron which carries the primary winding is fastened into the motor case with screws. The rotor of the motor is fastened to the motor shaft by means of a special sleeve, so that the motor can subsequently be arranged on the car axle for direct driving. The active iron of the rotor is held together by a number of screws and pressure discs, and carries the secondary winding. On the rotor sleeve two collector rings are held by a second sleeve, and the current is collected from the rings by means of carbon brushes. There are three apertures in the upper casting of the motor case on the collector-ring side, to render possible the inspection of the motor within. The motor itself is lubricated by means of oil and wicks, the oil being contained in vessels screwed on to the motor, and communicating with the bearings by copper tubes, this arrangement having been rendered necessary by the small space available.

To obtain a better casting, the axle bearings are screwed on to the motor casing. On the other hand, the lugs which, with the assistance of the springs, transfer the weight of the motors and the turning movement to the underframe, are cast directly on to the motor casing.

In the first Siemens & Halske's Zossen motor car, described in the previous article above referred to, the primary winding of the motor was on the rotor. This is only feasible with bar winding, which is not applicable in this case owing to the high pressure. In this case, also, it is not necessary to construct the motor for a very high turning moment, as, in consequence of the smaller weight of the car, smaller starting torque is necessary. The rotor may, therefore, be of smaller diameter, and the primary winding can be placed on the stator. In order to afford as large a cooling surface as possible, the slots are made fairly deep, so that the coils are thin and wide. A calculation of the conditions of saturation of the active iron gave a

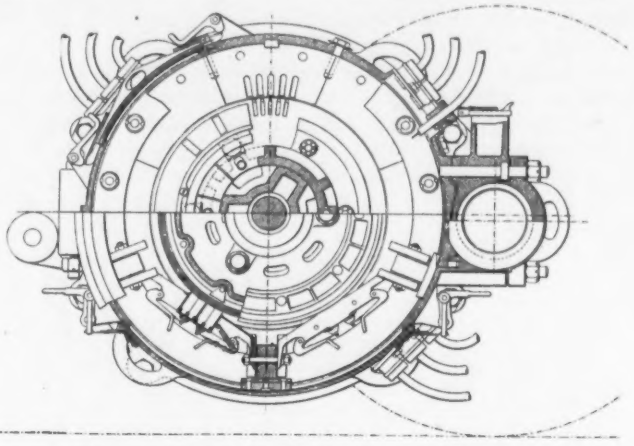


FIG. 3.—SECTIONAL ELEVATION OF MOTOR.

radius of about 13.8 inches (34 cm.) for a width of 11.8 inches (30 cm.). The cores of both stator and rotor consist of laminations, those for the rotor being stamped in one piece, and those for the stator being made up of segments. The calculation for the winding gave 72 open slots, and 72 wires per slot of the primary. Star connection is employed, and the wires are placed in mica tubes. To save space and to secure certainty of insulation the coils are placed alternately in longer and shorter tubes, so the longer ends always lap over the shorter ones. By this means the possibility of sparking over from one phase to another is considerably reduced. The method of insulating the high-pressure winding was determined upon after several trials, in the final one of which the winding withstood a pressure of 22,000 volts without disclosing any sign of a fault.

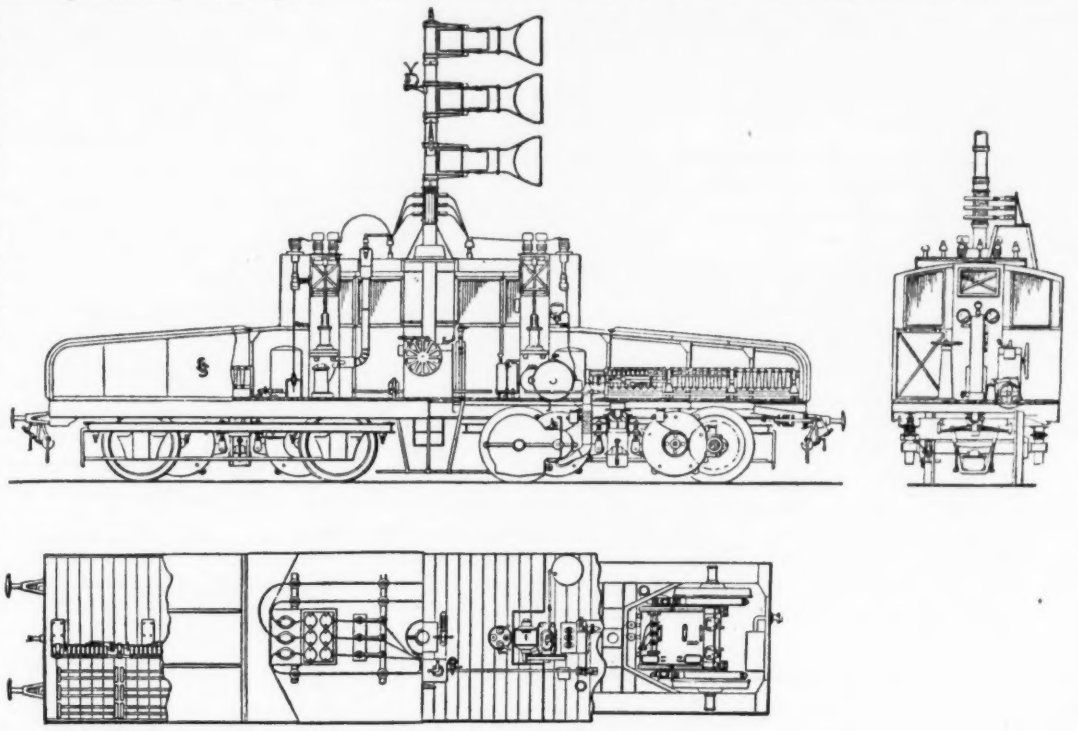


FIG. 4.—PLAN AND ELEVATIONS OF LOCOMOTIVE.

The winding of the rotor is placed in 90 half-closed slots, and consists of a number of single flat copper bars arranged in series and four in each slot. It is a wave winding connected in star. The three free ends are connected to two slip rings and the frame of the rotor, respectively. At starting, the pressure in the rotor winding is 700 volts. The employment of bars for the rotor winding facilitates the addition of bronze binding wires, and also permits of a very effective ventilation. The air enters the neighborhood of the shaft and is directed outwards through the openings in the rotor casting by vanes which are cast on to the latter. This current of air also cools the stator coils. Tests have shown that the air pressure thus caused corresponds to several millimeters of water. The velocity of the air was about 19.6 feet (6 meters) per second, and about 4½ cubic feet (120 litres) of air was forced through per second. To prevent the

high-pressure sparking over when the motor gets warm, the inside of the frame is covered with a thick layer of mica wherever it is adjacent to the primary winding, and the distance of this winding from the frame is always kept as large as possible.

The leading-in of the three high-pressure cables is done with particular care. The cables, which are insulated to stand 15,000 volts, are led through three soft rubber brushes, which are placed inside hard rubber brushes. They end in the three terminals which are mounted on corrugated porcelain insulators attached to saddles which

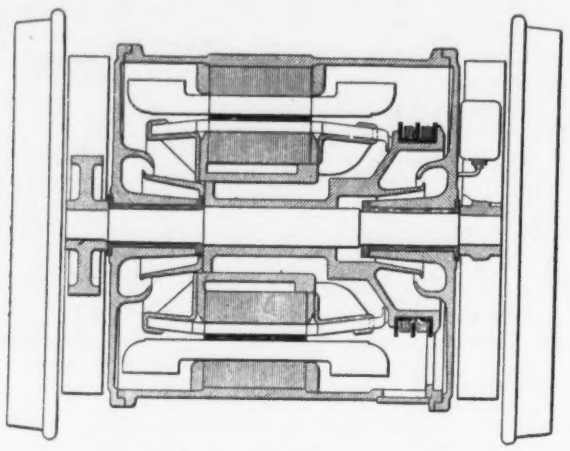


FIG. 5.—SECTIONAL VIEW OF MOTOR.

are supported on mica-insulated iron tubes fixed to the casing of the motor. The weight of the motor and gear is 9,000 lbs. (4,090 kg.).

Fig.. 6 shows the connections of the motor and controller. With the exception of the resistances, nearly all the apparatus employed is similar to that used in the previous experimental car. The speed at starting is regulated by varying the resistance in the rotor or secondary circuit. This is insulated from earth, as the third secondary phase of the motor is connected to earth through the motor shaft, as already stated. The current to the stator coils passes from the main switch through fuses. As shown, the switch is driven by an air piston, and at the same time it serves as a reversing switch by charging the phases. The motor driving the pump for compressing the air is driven through a 10,000 : 110-volt transformer.

The rotor resistance has 24 steps, and the resistance coils are spirals of Kruppin wire, held by porcelain insulators on an iron frame, and presents no new features. A hand-wheel on a vertical spindle controls this resistance. The switches for the primary high-pressure circuit are of the tubular type, and, as already stated, are worked

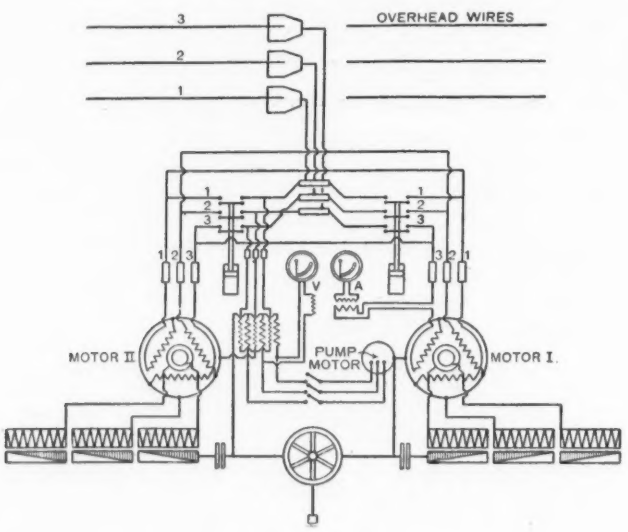


FIG. 6.—GENERAL DIAGRAM OF CONNECTIONS.

by air pressure. Both the high-pressure switches and fuses are placed in the cable ways behind the motors, and are visible through glass windows.

When the locomotive was completed, tests were made at a gradually increasing pressure, starting at 6,000 volts and about 50 alternations. The final test was made at 11,000 volts and 95 alternations, and with a trailer weighing 31 tons, and a speed of 65 miles (105 km.) per hour was attained. The toothed gear ran fairly quietly, and the motor stood the high pressure. About 260 kw were developed. This corresponds to a load of about 280 hp on the driving wheels, which agrees with experience already obtained at 62 miles (100 kw) per hour.

The Armature Reaction of Alternators—II.

BY C. F. GUILBERT.

CASE OF A SINGLE-PHASE ALTERNATOR.

IN order to simplify calculations, we will suppose that the current is entirely wattless—that is to say, in quadrature with the no-load voltage. The current in phase with the voltage at no-load gives rise to no mean direct magnetomotive force. One can, in fact, admit, as Blondel has proposed, that the total current can be decomposed in its two components, $I \sin \psi$ and $I \cos \psi$, ψ being the phase angle of the current with the no-load voltage.

We will retain the notation used previously, and referring to Fig. 1, let b^1 be the width of an armature coil from one axis to the other of the slots. The width, b^1, which we will take for the spreading of the poles, is not the width of the latter, but the width of the flux proceeding therefrom and entering into the armature, as has previously been explained.

We will calculate for each relative position the magnetomotive force due to the armature at all the points of the polar width, b, in assuming that this magnetomotive force varies suddenly from the quantity $N I \sqrt{2}$, along each axis of a slot. We will take the mean of this magnetomotive force at each point in order to obtain the mean magnetomotive force for the position considered. Finally, we will take the mean magnetomotive force during a half period or, more exactly, during a quarter period, which amounts to the same thing.

Let the current be expressed by $i = I_0 \cos \frac{\pi x}{a}$; x will thus designate the displacement of the axis of the inducing pole with respect to an axis of the induced pole.

We will suppose in order to fix ideas that the width b is superior to b^1; and the relative positions will be divided into three series.

1. $x < \frac{b - b^1}{2}$. As long as x is comprised between $_0$ and $\frac{b-b^1}{2}$ the induced coil remains in the interior of the space b; the mean magneto-motive force with relation to the surface $A\,B\,C\,D$ and width b is

$$N I_0 \cos \frac{\pi x}{a} \times \frac{b^1}{b},$$

N being the number of turns of the coil or the number of conductors per slot.

2. If x is greater than $\frac{b-b^1}{2}$ but less than PQ, then $\frac{a-b}{2} + \frac{a-b^1}{2} = a - \frac{b+b^1}{2}$, the induced coil has partly left the space b, and the mean magnetomotive force is only

$$\frac{\text{surface } A\,B\,C\,D}{b} = N I_0 \cos \frac{\pi x}{a} \left[b^1 - \left(x - \frac{b - b^1}{2} \right) \right] \frac{1}{b}$$

$$= N I_0 \cos \frac{\pi x}{a} \left(\frac{b + b^1}{2} - x \right) \frac{1}{b}$$

3. Beyond the value $a - \frac{b+b^1}{2}$, of x, the space b comprises a part of the coil of a pole, which is the seat of an opposite magnetomotive force, and consequently additative to that of the inducing pole considered.

It is thus necessary to take the differences of the rectangles $A\,B\,C\,D$ and $A^1\,B^1\,C^1\,D^1$, whence

$$\frac{\text{surface } A\,B\,C\,D - \text{surface } A^1B^1C^1D^1}{b} = N I_0 \cos \frac{\pi x}{a} \left[b^1 - \left(x - \frac{b - b^1}{2} \right) \right] - \left[x - \left(\frac{a - b}{2} + \frac{a - b^1}{2} \right) \right] = N I_0 \cos \frac{\pi x}{a} (a - 2x) \frac{1}{b}$$

The mean magnetomotive force during a half period is obtained

then for an inducing pole having an apparent width b, by taking the sum

$$F_i = \frac{2}{a}\left[\int_0^{\frac{b-b^1}{2}} N I_0 \cos\frac{\pi x}{a}\times\frac{b^1}{b}\,dx + \int_{\frac{b-b^1}{2}}^{\frac{a}{2}} N I_0 \cos\frac{\pi x}{a}\left(\frac{b+b^1}{2} - a\right)\frac{dx}{b} + \int_{a-\frac{b+b^1}{2}}^{\frac{a}{2}} N I_0 \cos\frac{\pi x}{a}\,(a-2x)\,\frac{dx}{b}\right]$$

To integrate the different impressions it suffices to assume $\frac{\pi x}{a} = y$ The mean magnetomotive force is then

$$F_i = \frac{2 N I_0}{\pi b}\left[b^1\int_0^{\frac{b-b^1}{a}\frac{\pi}{2}} \cos y\,dy + \int_{\frac{b-b^1}{a}\frac{\pi}{2}}^{\pi-\frac{b+b^1}{a}\frac{\pi}{2}} \left(\frac{b+b^1}{2} - \frac{a y}{\pi}\right)\cos y\,dy + \int_{\pi-\frac{b+b^1}{a}\frac{\pi}{2}}^{\frac{\pi}{2}} \left(a - \frac{2 a y}{\pi}\right)\cos y\,dy\right]$$

These integrations offer no difficulties but lead, all reductions being made, to particularly simple results, as follows:

$$F_i = \frac{4}{\pi^2}\,\frac{a}{b}\,N I_0 \sin\frac{b}{a}\frac{\pi}{2}\sin\frac{b^1}{a}\frac{\pi}{2} \qquad (4)$$

or, by introducing $Io \sin\psi$ for the maximum wattless current, we have

$$F_i = \frac{4}{\pi^2}\,\frac{a}{b}\,N I_0 \sin\frac{b\pi}{a\,2}\sin\frac{b^1\pi}{a\,2}\sin\psi \qquad (5)$$

We have assumed $b > b^1$; the calculation leads to the same result when $b < b^1$, except when b is inferior to $a - b^1$, a condition evidently never met with. When each induced coil consists of several concentric coils, the formula is applied to each and the results added. As a particular case, if each pole has six slots, of which four only are utilized, we have

$$F_i = \frac{4}{\pi^2}\,\frac{a}{b}\,N I_0 \sin\frac{b}{a}\,\frac{\pi}{2} \times 0.836 \sin\psi \qquad (6)$$

N always representing the number of conductors per complete coil, or double the number of turns per pole. With eight slots, of which six are utilized, we have

$$F_i = \frac{4}{\pi^2}\cdot\frac{a}{b}\,N I_0 \sin\frac{b}{a}\,\frac{\pi}{2} \times 0.81 \sin\psi \qquad (7)$$

It may be objected that formula (5) does not take account of the width of the opening of the slots. It would be a simple matter to correct the formula to take into account this width by assuming that the induced ampere-turns decrease linearly from one edge of a slot to the other. The calculation leads readily to the following expression, β being the width of the opening:

$$\frac{\pi}{64}\,N I\left(\frac{\beta}{a}\right)^3 \sin\frac{b}{a}\cdot\frac{\pi}{2}\cos\frac{b^1}{a}\cdot\frac{\pi}{2} \qquad (8)$$

which should be added to the value as above determined of F_i. This expression shows that the correction may be neglected.

CASE OF A POLYPHASE ALTERNATOR.

In the case of a polyphase machine, it is apparent that a calculation analogous to the preceding one can be made, but introducing the different phases in such a manner that their combined effect enters. It is evident that each phase will figure as if it alone were acting, since the integral of a sum is equal to the sum of the integrals of the different parts, and it will, therefore, be possible to divide the several integrals in three groups which will give the same sum. The expression in this case for the ampere-turns will thus be

$$F_i = m\,\frac{4}{\pi^2}\,N I_0\,\frac{a}{b}\sin\frac{b}{a}\cdot\frac{\pi}{2}\sin\frac{b^1}{a}\cdot\frac{\pi}{2}\sin\psi \qquad (9)$$

assuming always that there are N turns per pole of the induced element. This amounts to saying that it is necessary to couple two by two the slots that are not adjacent to the same pole, thus constituting as many fictive slots, of which the width, b^1, will be introduced into the formula. Some examples will make this method clear.

1°. Take first the case of a three-phase alternator having one slot per pole and phase. We then have, if $2N$ is the number of turns per coil, N turns per pole; and since $b_1 = a$, we have

$$F_i = 3\,\frac{4}{\pi^2}\,N I_0\,\frac{a}{b}\sin\frac{b}{a}\cdot\frac{\pi}{2}\sin\psi \qquad (10)$$

Designating by N the number of conductors per pole and per phase ($N_1 = 2N$).

$$F_i = \frac{3}{2}\cdot\frac{4}{\pi^2}\,N_1 I_0\,\frac{a}{b}\sin\frac{b}{a}\cdot\frac{\pi}{2}\sin\psi \qquad (11)$$

2°. Next take the case of a three-phase alternator having two slots per pole and per phase. The two slots not adjacent to the same phase are distant $\frac{5}{6}\,a$, and consequently $b^1 = \frac{5}{6}\,a$; therefore, N, being the number of conductors per pole and per phase ($N_1 = 2N$), we have

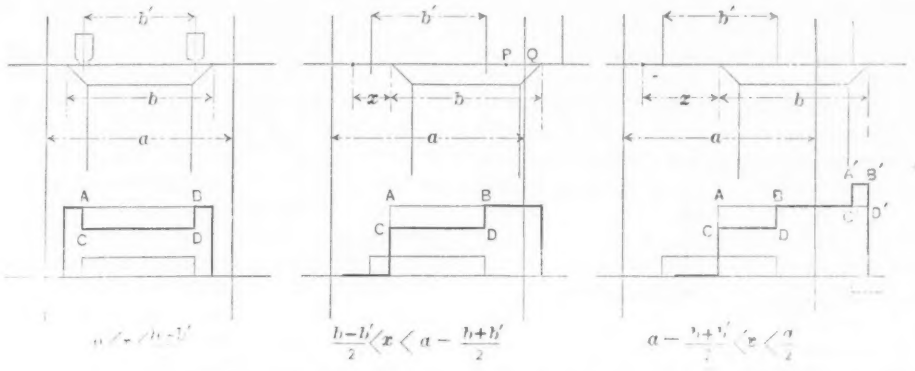


FIG. 1.—CASE OF A SINGLE-PHASE ALTERNATOR.

$$F_i = \frac{3}{2}\cdot\frac{4}{\pi^2}\,N_1 I_0\,\frac{a}{b}\sin\frac{b}{a}\cdot\frac{\pi}{2}\sin 75^\circ\sin\psi$$

$$= 0.588\,N_1 I_0\,\frac{a}{b}\sin\frac{b}{a}\cdot\frac{\pi}{2}\sin\psi \qquad (12)$$

3°. With three slots per pole and per phase, it is readily seen that there is one coil of $\frac{N}{3}$ turns per pole and one of $\frac{2N}{3}$ turns. We thus have for the first $b^1 = a$, and for the second $b^1 = \frac{7a}{9}$, N_1 being equal to $2N$.

$$F_i = \frac{3}{2}\cdot\frac{4}{\pi^2}\,N_1 I_0\,\frac{a}{b}\sin\frac{b}{a}\,\frac{\pi}{2}\left[\frac{1}{3}\sin\frac{\pi}{2} + \frac{2}{3}\sin 70^\circ\right]$$

$$\sin\psi = 0.584\,N_1 I_0\,\frac{a}{b}\sin\frac{b}{a}\cdot\frac{\pi}{2}\sin\psi \qquad (13)$$

The Use and Advantages of the Alternating Current for Land Telegraphy—I.

BY EDWIN F. NORTHRUP.

MUCH theoretical and practical work has been done in the last few years in applying the alternating current to wire telegraphy. The public, however, has had little information concerning what has been accomplished. The purpose of this paper is to furnish some information and to describe and discuss the fundamental electrical principles involved in applying the alternating current to transmitting telegraphic signals, and in maintaining synchronous motion over long telegraph lines.

It is to the late Professor Henry A. Rowland, of Johns Hopkins University, Baltimore, Md., that are chiefly due the interesting and valuable results that have been accomplished in alternating current telegraphy. He first turned his attention to the matter of devising new methods in telegraphy in 1895 and devoted the greater portion of his time and thought to the subject until his death in April, 1901. The beautiful system known as the "Rowland Multiplex Printing Telegraph" is the result of his labors and genius. My purpose is not, however, to describe this particular telegraph system, but rather to discuss in a broad way the electrical principles involved, and the advantages to be derived by employing an alternating current on a telegraphic land line for maintaining synchronous motion and for trasmitting signals.

I shall not, therefore, describe any special devices or mechanical features employed by the Rowland or other telegraph systems. Anyone desiring to inform himself regarding the particular contrivances by means of which results, that I shall mention, have been accomplished, can obtain such information from United States patents recently granted for inventions in alternating current telegraphy.

In the ordinary telegraphic methods of the Morse, Wheatstone and other systems, current is supplied to the line only at the moment when a signal is being transmitted. This momentary signaling current may be made to flow in either direction by putting to the line either pole of the current source. Telegraphing with such reversed currents, where each current impulse produces a whole or a part of a signal, does not constitute the kind of alternating current telegraphy that we are about to consider.

In the above case to transmit the signal, current is supplied to the line which at other times may be without current. In true alternating-current telegraphy, on the other hand, a current is continuously maintained upon the line, and the sending of a signal is accomplished by cutting out, or modifying in some manner, one or more of the alternating-current waves. Curiously enough, as will later appear, two signals can be simultaneously transmitted, by this latter system, at a moment, when there is no current flowing on the line.

Most of the results which have been obtained by the use of an alternating current on the line have, also, been accomplished by using a pulsating current, which rises to a maximum value and falls to zero with periodic regularity. Such a current is, in fact, only an alternating current which has been modified, by having added to it a direct current, of value equal to the maximum value above zero of the wave of the alternating current. I shall, however, confine myself to a discussion of the use of the alternating current proper. For telegraphic purposes this current is equally effective, however produced, and whatever may be the form of its waves. A direct current, which is periodically reversed, with sufficient rapidity, by means of commutating devices serves in practice quite as well as an alternating current of pure sine wave form. However, by assuming the current to have a sine wave form, a discussion of the manner in which the current is propagated in a long telegraph line is rendered much easier.

The ultimate perfection of any system must be chiefly dependent upon the theoretical possibilities of the signaling capacity of the line current that is employed. The ingenuity and the perfection of the electrical and mechanical devices of any system must, finally, be of small relative importance compared with this. We are thus led to inquire how an alternating current flows in very long lines, such as are used in telegraphy. And the following problems, as being of most immediate consequence, ought to be considered.

What is the greatest practical length of an overhead telegraph line, as lines are at present constructed, over which it is possible to transmit clear signals; first, when the line is not duplexed, and, second, when duplexed signaling is maintained?

In what manner, and to what extent, can the construction of present lines be modified so as to increase the length of transmission?

In what manner, and how rapidly, can signals be impressed upon the line current?

In discussing the above and other questions which will arise, it is not necessary to consider how the signals are translated after being received, and it is entirely needless to consider the special character of any of the local apparatus, which is not directly in circuit with the line. In order, however, to bring the questions to be considered into more definite form I shall assume, that sufficient current is received at the end of the line to maintain in rapid vibration the tongue of a polarized relay, connected in series with the line. Practical tests show, that for this purpose, the received current should be about 25 milliamperes. As will be shown later, if the tongue of such a relay can be kept by the alternating-line current in rapid vibration, perfect synchronous motion can be maintained between the moving apparatus at the two ends of the line, and signals can be transmitted at great rapidity, and can be automatically translated into any desired form, such as Morse signals or printed characters.

In telegraphy a single line wire with ground return is invariably used. When a line is several miles long and a periodic e. m. f. is continuously applied at one end, the current which flows in the line varies in phase and in intensity from point to point of the line. The various relations of the currents, the e. m. f.'s and their phases can, however, be accurately investigated by mathematical analysis.

Every telegraph line has four constants, none of which can be

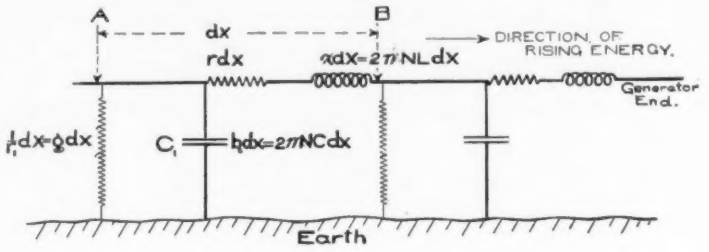


FIG. I.—REPRESENTATION OF OVERHEAD LINE.

neglected in rigid calculations. These constants are the resistance, the capacity, the self-induction and the leakage of the line. When an alternating current starts from the generator end and flows down a long line, some of the electricity escapes from the line, and some goes to charging the static capacity of the line, so that the current which is received at the far end, for maintaining the relay in vibration, is only a fracton of that which enters the line. In order to adequately investigate just how the current is propagated and to determine what proportion of the current, which enters the line, will reach the far end, and serve for transmitting signals, it is necessary to resort to a mathematical analysis of the manner of flow of alternating currents in long lines.

The fundamental equations, necessary to a complete discussion of the subject, have been beautifully derived by Mr. Steinmetz and are to be found on page 169 in his book, "Alternating Current Phenomena." He has, however, only applied these equations to the discussion of problems relating to power transmission lines. I shall make free use of his analysis and results, in obtaining expressions convenient to use in the discussion of alternating current telegraph problems.

In Fig. 1 a portion of a single overhead line is symbolically represented. Let the section A to B be a differential element of the line. For such a line there are four constants that must be considered: These constants per unit length of the line are the resistance, r, the reactance, $x = 2\pi N L$, where N is the frequency and L the self-induction per unit length of the line, the conductance, $g = \frac{1}{r_1}$ where r_1 equals the resistance of the insulation per unit length of line, and the susceptance, $b_c = 2\pi N C$, where C equals the static capacity against ground per unit length of line.

Consider X positive when measured in the direction of rising energy, that is, towards the generator end of the line. In the above line, e. m. f. is consumed by the resistance, which is in phase with

the current, the e. m. f. consumed in the element, dX being $I\,r\,dX$ where I is the current. E. m. f. is also consumed by the reactance, x, of the line.

This e. m. f. is in quadrature with the current, and the portion consumed in the element dX is $-jIx\,dX$, where $j=\sqrt{-1}$, and symbolizes rotation of the vector through 90 degs. Then the total e. m. f. consumed in the element, dX, is,

$$dE=I\,(r-jx)\,dX \qquad (1)$$

In the element dX there are likewise two sources of current consumption. Current will leak out of the element, dX, through the insulation equal to $\frac{E}{r_1}\,dX=E\,g\,dX$, and this current will be in phase with the e. m. f. Current will also flow into the condenser C_1, that is, be consumed by the capacity of the line, and will be 90 degs. ahead of the e. m. f. This current will equal $-j\,E\,b_c\,dX$. The total consumption of current in the element then is,

$$dI=E\,(g-jb_c)\,dX \qquad (2)$$

We derive from (1) and (2), by differentiation, the two following differential equations, which have the same general form and express all the relations of the current and the e. m. f. in a long alternating-current line, having resistance, leakage, self-induction and distributed capacity.

$$\frac{d^2E}{dX^2}=E\,(r-jx)\,(g-jb_c) \qquad (3)$$

$$\frac{d^2I}{dX^2}=I\,(r-jx)\,(g-jb_c) \qquad (4)$$

For the method of solving these equations the reader must be referred to Mr. Steinmetz' book, "Alternating Current Phenomena," pages 167-169. I have carefully verified the solutions there given. They are:

$$E=\frac{1}{g-jb_c}\left\{(A\varepsilon^{\alpha X}-B\varepsilon^{-\alpha X})\cos\beta X-j(A\varepsilon^{\alpha X}+B\varepsilon^{-\alpha X})\sin\beta X\right\} \qquad (5)$$

$$I=\frac{1}{a-j\beta}\left\{(A\varepsilon^{\alpha X}+B\varepsilon^{-\alpha X})\cos\beta X-j(A\varepsilon^{\alpha X}-B\varepsilon^{-\alpha X})\sin\beta X\right\} \qquad (6)$$

In these solutions A and B are the two constants of integration. Their values can always be determined for particular cases. We will determine them for the special cases we have to consider, but must refer the reader again to Steinmetz for a discussion of the general methods of determining the constants.

a and β are two symbols introduced into the equations merely as abbreviations. Their values are:

$$a=\sqrt{\tfrac{1}{2}\left\{\sqrt{(r^2+x^2)\,(g^2+b_c^2)}+(g\,r-x\,b_c)\right\}} \qquad (7)$$

$$\beta=\sqrt{\tfrac{1}{2}\left\{\sqrt{(r^2+x^2)\,(g^2+b_c^2)}-(g\,r-x\,b_c)\right\}} \qquad (8)$$

Equations (5) and (6) can be made to express the relations of the current and e. m. f. in a line with ground return, or a double line feeding into any kind of receiver circuit. For problems relating to telegraphy, however, very much simplified solutions can be derived by making the assumption that the line is a single wire and feeds directly into the ground which serves as the return circuit. The telegraph line in reality has relays in circuit with it at each end, but, their disturbing influence upon the flow of the current, as expressed in the equations used, is small, and their influence may be neglected in arriving at the solutions of the problems before us.

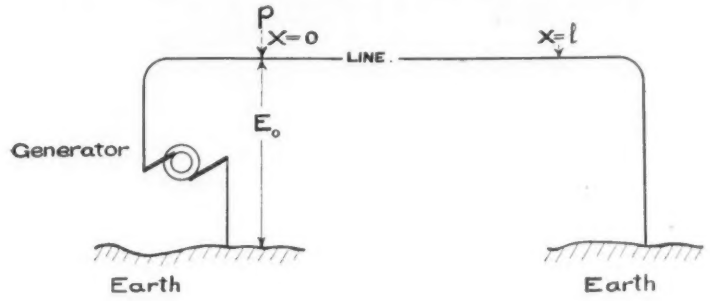


FIG. 2.—LINE CARRYING ALTERNATING CURRENT.

We have first to inquire what are all the relations of intensity and phase, of both current and e. m. f., in a long telegraph line carrying an alternating current and grounded at its far end. Let Fig. 2 represent such a line.

Equations (5) and (6) assume that X is counted positive in the direction of rising energy, that is, towards the generator. Since the measurements on a telegraph line for determining the values of the constants A and B are most conveniently made near the generator end of the line, it will be preferable to count X positive in the direction of decreasing energy, and to arbitrarily select some point, p, as the beginning of the line where $X=O$. If we do this, X, in equations (5) and (6) will change into $-X$, and the equations will become

$$E=\frac{1}{g-jb_c}\left\{(A\varepsilon^{-\alpha X}-B\varepsilon^{\alpha X})\cos\beta X+j(A\varepsilon^{-\alpha X}+B\varepsilon^{\alpha X})\sin\beta X\right\} \qquad (9)$$

$$I=\frac{1}{a-j\beta}\left\{(A\varepsilon^{-\alpha X}+B\varepsilon^{\alpha X})\cos\beta X+j(A\varepsilon^{-\alpha X}-B\varepsilon^{\alpha X})\sin\beta X\right\} \qquad (10)$$

To completely solve equations (9) and (10) and obtain numerical values it is only necessary to know the values of the four constants, $r, g, x,$ and b_c of the line; its length from the point p to where it is grounded and the potential difference between the line and ground at the point, p, where $X=O$. Assume the e. m. f. at the point $X=O$ as the zero vector. Since by giving X the value O in equation (9)

$$E=E_0=\frac{1}{g-jb_c}\,(A-B)$$

$$A-B=E_0\,(g-jb_c) \qquad (11)$$

The phases of the current and e. m. f. begin to repeat themselves, and the line is said to be one wave length long, if $X=\frac{2\pi}{\beta}$. Let the line be assumed to have this length. Then, as it is put to earth, at its end, $E=O$ when $X=\frac{2\pi}{\beta}$ and equation (9) gives

$$E=O=\frac{1}{g-jb_c}\left(A\varepsilon^{-\frac{2a\pi}{\beta}}-B\varepsilon^{\frac{2a\pi}{\beta}}\right)$$

whence;

$$A\varepsilon^{-\frac{2a\pi}{\beta}}=B\varepsilon^{\frac{2a\pi}{\beta}} \qquad (12)$$

From the relations (11) and (12) we derive

$$A=\frac{E_0\,(g-jb_c)}{1-\varepsilon^{-\frac{4a\pi}{\beta}}} \qquad (13)$$

$$B=\frac{E_0\,(g-jb_c)}{\varepsilon^{\frac{4a\pi}{\beta}}-1} \qquad (14)$$

Substitute the values of A and B in equations (9) and (10) and we obtain

$$E=E_0\left\{\left(\frac{\varepsilon^{-\alpha X}}{1-\varepsilon^{-\frac{4a\pi}{\beta}}}-\frac{\varepsilon^{\alpha X}}{\varepsilon^{\frac{4a\pi}{\beta}}-1}\right)\cos\beta X+\right.$$

$$\left.j\left(\frac{\varepsilon^{-\alpha X}}{1-\varepsilon^{-\frac{4a\pi}{\beta}}}+\frac{\varepsilon^{\alpha X}}{\varepsilon^{\frac{4a\pi}{\beta}}-1}\right)\sin\beta X\right\} \qquad (15)$$

$$I=\frac{E_0\,(g-jb_c)}{a-j\beta}\left\{\left(\frac{\varepsilon^{-\alpha X}}{1-\varepsilon^{-\frac{4a\pi}{\beta}}}+\frac{\varepsilon^{\alpha X}}{\varepsilon^{\frac{4a\pi}{\beta}}-1}\right)\cos\beta X+\right.$$

$$\left.j\left(\frac{\varepsilon^{-\alpha X}}{1-\varepsilon^{-\frac{4a\pi}{\beta}}}-\frac{\varepsilon^{\alpha X}}{\varepsilon^{\frac{4a\pi}{\beta}}-1}\right)\sin\beta X\right\} \qquad (16)$$

Equations (15) and (16) are complete solutions for the e. m. f. and current in a line one wave length long, grounded at the far end and where the e. m. f., E_0, at the beginning of the line is known. The forms, however, of equations (15) and (16) lead to rather lengthy calculations in obtaining numerical values. The constant, B, in the case of a line one wave length long, grounded at the end, is very nearly equal to zero, and if the line were infinitely long would exactly equal zero. To a close approximation B can be con-

sidered equal to zero and equations (15) and (16) will reduce very much. Thus $1-\epsilon^{-\frac{4a\pi}{\beta}}$ is very nearly equal to 1, and $\frac{\epsilon^{aX}}{\epsilon^{\frac{4a\pi}{\beta}}-1}$ nearly zero. Then we can write,

$$E_1 = E_0 \epsilon^{-aX} (\cos \beta X + j \sin \beta X) \qquad (17)$$

and

$$I_1 = E_0 \epsilon^{-aX} \frac{g - j b_c}{a - j\beta} (\cos \beta X + j \sin \beta X) \qquad (18)$$

Equations (17) and (18) are easily applied to calculating numerical values when the values of the line constants are calculated, assumed, or experimentally measured. We proceed to obtain numerical values and to plot curves for a telegraph line of No. 9 hard-drawn copper wire. We will assume this line to be 20 feet above ground on poles by itself. We will take the kilometer as the unit of length. The effective resistance, which should strictly be taken to include all energy losses due to consumption of e. m. f. in phase with the current, may here with sufficient exactness be taken as the ohmic resistance per kilometer length of line. Its value will then be $r = 2.672$ ohms. The insulation resistance of the line, r_1, we will assume to equal one megohm per kilometer.

Hence $g = \frac{1}{r_1} = \frac{1}{10^6} = 10^{-6}$, $x = 2\pi N L$, where N is the frequency or number of complete periods of the current per second, and L the self-induction of the line per kilometer. Practice has shown that, for printing telegraphy, the best results are obtained when $N = 100$. The value of the self-induction may be calculated from the formula, $L = 2 \times 10^{-4} \log_\epsilon \frac{4D}{\delta}$ henrys per kilometer, where δ equals diameter of conductor, D equals height of wire above ground. Assuming $D = 20$ feet we derive $L = .0018$ henrys per kilometer. Whence $x = 1.13$.

The constant $b_c = 2\pi N C$, where C is the static capacity of the line against ground per kilometer of length. It may be calculated by the formula,

$$C = \frac{.111 \times 10^{-6}}{2 \log_\epsilon \frac{4D}{\delta}}$$

farads per kilometer.

For No. 9, wire 20 above ground $C = .0062 \times 10^{-6}$. Whence $b_c = 3.89 \times 10^{-6}$. Having the values of the four line constants we obtain for the values of a and β, page —,

$$a = 2.23 \times 10^{-3}$$
$$\beta = 2.59 \times 10^{-3}$$

Since we have chosen the line to be one wave length long, its length is $\frac{2\pi}{\beta} = \frac{6.283}{2.59 \times 10^{-3}} = 2425$ kilometers or 1,515 miles.

With these numerical values for the constants of the line I have given numerical values to the constant terms of the exact equations (15) and (16) and obtained

$$E = E_0 \{(1.00002045 \epsilon^{-aX} - .00002045 \epsilon^{aX}) \cos \beta X + j (1.00002045 \epsilon^{-aX} + .00002045 \epsilon^{aX}) \sin \beta X\} \qquad (19)$$

$$I = 10^{-5} E_0 \{[(105 \epsilon^{-aX} + .00215 \epsilon^{aX}) \cos \beta X - (52 \epsilon^{-aX} - .00106 \epsilon^{aX}) \sin \beta X] + j [(52 \epsilon^{-aX} + .00106 \epsilon^{aX}) \cos \beta X + (105 \epsilon^{-aX} - .00215 \epsilon^{aX}) \sin \beta X]\} \qquad (20)$$

If *in* general $I = K(a + jb)$, the absolute value of I is $K\sqrt{a^2 + b^2}$ and the phase of I is $\omega = \tan^{-1} \frac{b}{a}$

With aid of equations (19) and (20) (though the approximate equations (17) and (18) would have served as well for practical purposes) I have plotted (4) curves, calculating 25 points for each curve.

Curve No. 1 gives the intensity of the e. m. f. at all points along the line assumed to be one wave length long (2,425 kilometers).

The values of the e. m. f. as given by the curve are to be multiplied by the e. m. f. given to the line at its generator end to obtain the actual absolute values.

Curve No. 2 gives the relative values of the current at all points of the line. To get the absolute values, the values as given by the curve must be multiplied by $E_0 10^{-5}$. Thus if E_0 is made 100 volts the current at the beginning of the line is 117 milliamperes.

Curve No. 3 gives the phase, in degrees, of the e. m. f. at all points of the line, its phase at the beginning of the line being taken as the zero vector. Curve No. 4 gives the phase in degrees of the current at all points of the line, the phase of the e. m. f. at the beginning of the line being retained as zero vector.

Equations (15) and (16) or the approximate equations (17) and (18), and curves Nos. I., II., III. and IV., contain much information regarding the possibilities of telegraphing long distances with alternating currents.

Referring to curve No. 2 we note that the current has decreased

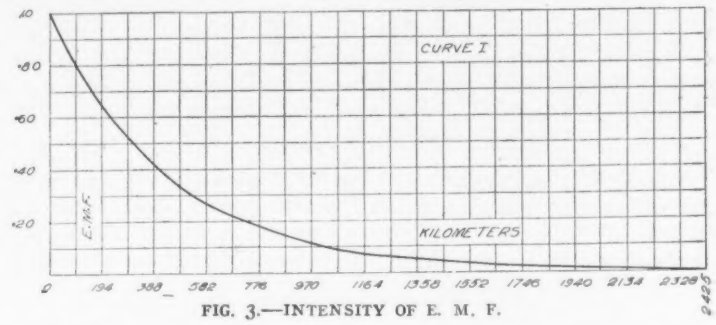


FIG. 3.—INTENSITY OF E. M. F.

to half the value which it has at the beginning of the line, in the first 310 kilometers or in about 194 miles. It has decreased to one-tenth of its initial value at a point about 1,028 kilometers, or 643 miles from the beginning of the line. At a distance of one wave length, or 2,425 kilometers, or 1,515 miles, the value of the current is only about $\frac{1}{11}$th of its initial value. But as the current at any point of the line will always be proportional to the e. m. f. applied

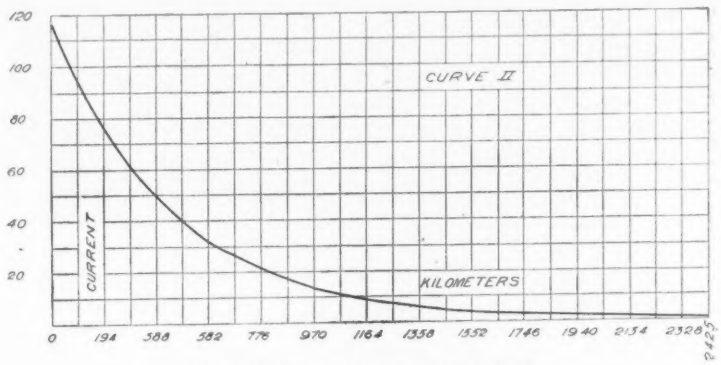


FIG. 4.—RELATIVE VALUE OF CURRENTS.

at the beginning of the line (as appears from equation 20) it is possible, by using a sufficiently high initial e. m. f., to deliver a current of any desired value, within limits suggested by line insulation, etc., to the end of a line even much longer than the one here considered.

The problem of how far it is possible to signal or telegraph with the alternating current, is seen by having regard to the above facts

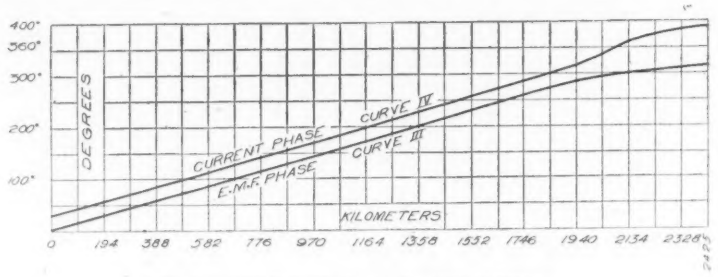


FIG. 5.—PHASES OF E. M. F. AND CURRENT.

respecting the flow of the current, to divide itself into two distinct problems.

The first is, how can signals be sent over a simplex line, that is, a line in which the signaling is only carried on in one direction at a time, there being no balanced or duplexed relays. The second problem is, how can signaling be carried on over a duplexed line, that is, a line in which signals are being sent simultaneously in opposite directions at the same time, a balanced or duplexed relay being in circuit with the line at each end, and each end of the line being supplied with a current source. We will consider the latter case first. Let a duplexed line be represented in Fig. 6.

Here (A) and (B) represent each a polarized differentially wound relay at opposite ends of the line, (D) and (D_1) alternating current generators or any other source of periodically alternating e. m. f.

(T) and (T_1) transmitters for breaking the line and cutting out or modifying in some manner the half waves of the alternating current for the purpose of signaling. a and a_1 are artificial lines with which to balance the relays (A) and (B). a is first adjusted so that when (T_1) puts the other end of the line to earth the current from (D) will not in the least effect relay (A). Then a_1 is adjusted, with the line at the opposite end put to earth, by means of (T) so that the current from (D_1) will not effect the relay (B).

When these adjustments can be accurately made, the duplexed line is balanced, and an operator at either end of the line can, by operating his transmitter effect the relay at the opposite end without effecting the relay at his own end. If, temporarily, it be assumed that a signal is impressed upon the alternating current by cutting out one of its half waves, then when (T) sends a signal to (B), the tongue of (B), which ordinarily vibrates continuously, from the continuously flowing alternating current, comes momentarily to rest. This pausing of the tongue of (B) is the form in which the signal sent from (T) is received at (B). At the same instant (T_1) can likewise send a signal in the same manner to (A), the signal being primarily received in the form of a momentary pause in the vibration of the tongue of (A). Thus, as previously stated, two signals may be simultaneously transmitted at the same instant when there is no current on the line, the line being put directly to earth at both ends at the same instant the signals are being received.

It will now be understood that the length of line over which duplex working can be maintained will depend upon how well the relays can be balanced at each end of the line. The two relays, one at each end, must be kept so accurately balanced that the cutting of the current off one end of the line will effect the relay at the

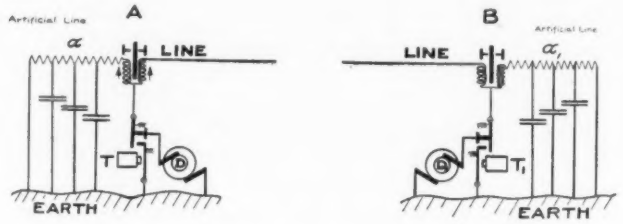


FIG. 6.—DUPLEXED LINE.

opposite end of the line far more than any accidental disturbances, or the current from the dynamo at its own end, effects it.

Thus if 7 units of the current from the dynamo (D) traverse the coils of relay (A) and 1 unit of current reaches (A) from the dynamo (D_1), (A) must be dead to the 7 units of current from (D) and vibrate from the 1 unit of current received from (D_1). When the current from (D_1) is cut off the tongue of (A) must practically cease to vibrate. Now, it becomes in practice, rapidly more difficult to accurately balance the duplex line as the line grows longer, or, more properly speaking, as the ratio of the current received at one end of the line to the current sent into the opposite end of the line, grows smaller. Only actual experience in working with lines will tell how small it is feasible for this ratio to be. If the ratio of received current to current sent is 1 to 6, experience shows that the line may be duplexed with considerable ease. For a line like that for which curve No. 11. was plotted a ratio of 1 to 6 would correspond to about 815 kilometers, or 510 miles. Such a distance is easily worked over duplex. If the ratio is as small as 1 to 10 it would be found quite difficult to maintain the relays sufficiently well balanced for continuous good working. If the relays are made less sensitive, then they are not sensitive to signals transmitted, and if their sensitiveness is increased they show a small lack of balance and are easily effected by slight line disturbances. Thus no change in the form of the relays can be made to increase the possible distance of duplex working. As a ratio of 1 to 10 is probably the extreme practical working limit, we have for a line of No. 9 copper wire, like that for which curve No. 2 was plotted, 1,028 kilometers, or 643 miles, as about the limit of practical duplex working with alternating currents of frequency 100. It should be parenthetically stated, that automatic relaying is perfectly feasible with alternating current telegraphy.

Underground Work for Telephone Exchanges—X.

BY ARTHUR V. ABBOTT, C. E.

TABLE No. 7 enumerates the probable prices for the various forms of duct material laid into place, calculated in a manner similar to the preceding tables, including a percentage column showing the effect of each item upon the total expense.

TABLE NO. 6.

Constant Cost per Conduit Foot in Dollars.

Item.	Minimum		Average		Maximum	
	Cost	Per Cent.	Cost	Per Cent.	Cost	Per Cent.
1 to 9 ducts.						
Excavation	.105	32.6	.1575	23.4	.210	13.0
Paving	.695	21.2	.185	27.5	.279	17.4
Engineering	.05	15.2	.08	11.9	.12	7.5
Removal of obstacles	.10	32.0	.25	37.2	1.00	62.1
Total	.3245	100.0	.6725	100.0	1.609	100.00
10 to 16 ducts.						
Excavation	.16	38.6	.24	29.1	.32	17.0
Paving	.0845	20.2	.222	27.0	.3315	17.7
Engineering	.05	12.1	.08	9.8	.12	6.5
Removal of obstacles	.12	29.1	.28	34.1	1.10	58.8
Total	.4145	100.0	.822	100.0	1.8715	100.0
17 to 25 ducts.						
Excavation	.225	43.0	.3375	32.8	.45	19.2
Paving	.0970	18.6	.26	25.3	.52	22.2
Engineering	.05	9.6	.08	7.8	.12	5.1
Removal of obstacles	.15	28.8	.35	34.1	1.25	53.5
Total	.522	100.0	1.0275	100.0	2.34	100.0

From the data thus collected, the total cost of a conduit of any size is readily determined by taking first the cost per foot of street for manholes and sewer connections; second, the cost of the constant street items as given in Table No. 5, depending upon the number of ducts, and, third, the cost per duct foot, determined from Table No. 6, multiplied by the number of ducts to be laid, and

TABLE NO. 7.

Cost of Duct Material in Place in Dollars.

Item.	Minimum		Average		Maximum	
	Cost	Per Cent.	Cost	Per Cent.	Cost	Per Cent.
Hollow brick.						
Duct material	.02	44.4	.035	36.8	.05	34.5
Placing	.005	11.2	.01	10.5	.015	10.3
Encasement	.02	44.4	.05	52.7	.08	55.2
Total	.045	100.0	.095	100.0	.145	100.0
Multiple Duct.						
Duct material	.035	67.5	.05	50.0	.065	46.7
Placing	.011	2.2	.0025	2.5	.004	2.9
Encasement	.015	30.3	.0475	47.5	.07	50.4
Total	.051	100.0	.10	100.0	.139	100.0
Cement Lined Pipe.						
Cement Pipe.						
Wood Pulp.						
Duct material	.04	62.5	.06	53.6	.08	48.2
Placing	.002	3.2	.004	3.4	.006	3.6
Encasement	.022	34.3	.05	43.0	.088	48.2
Total	.064	100.0	.114	100.0	.166	100.0
Creosoted Wood.						
Duct material	.04	98.04	.05	98.0	.06	95.0
Placing	.0008	1.96	.0015	3.0	.003	5.0
Encasement	.00	0.00	.00	0.0	.00	0.0
Total	.0408	100.00	.0515	100.0	.063	100.0

adding these three items together, giving immediately the total cost per conduit foot.

The use of these tables as described will give a more accurate, though somewhat more laborious estimate of cost of conduit construction than it is possible to gain by single assump-

tion of price per duct foot or per conduit foot, as would be necessitated by a cost exhibition in a single tabular or graphical form.

The cost of conduit construction is constantly and steadily decreasing, owing to improvement and cheapening in the manufacture of materials employed, natural competition tending to decrease prices, and increasing experience and skill in designing and building work of this character. Consequently actual conduit costs derived from experience are likely to be higher than would now be required to reconstruct the same system from which they were obtained. Nevertheless, graphical tables, Figs. 52, 53, 54 and 55, are given indicating average and maximum costs of construction of a number of large systems of conduit from actual experience. Fig. 52 shows average costs per conduit foot. Four lines will be found in this table, applying respectively to conduits from 1 to 9 ducts, 10 to 16 ducts, 17 to 25 ducts and 26 to 36 ducts. The horizontal scales at the top and bottom of these sheets indicate the number of

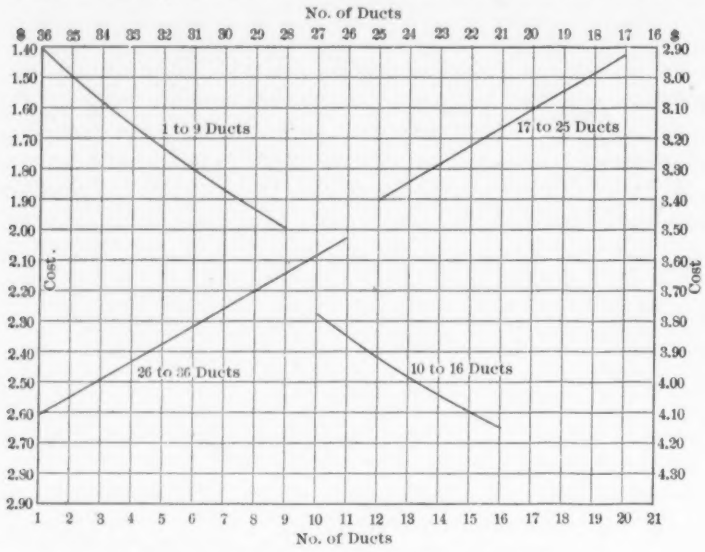


FIG. 52.—COST PER CONDUIT-FOOT; AVERAGE.

ducts, while the vertical scales at the right and left hand sides respectively give the cost per conduit foot. Fig. 53 is a similar table showing maximum prices. Fig. 52 is likely to apply to the middle and outer portions of large cities of, say, 200,000 in-

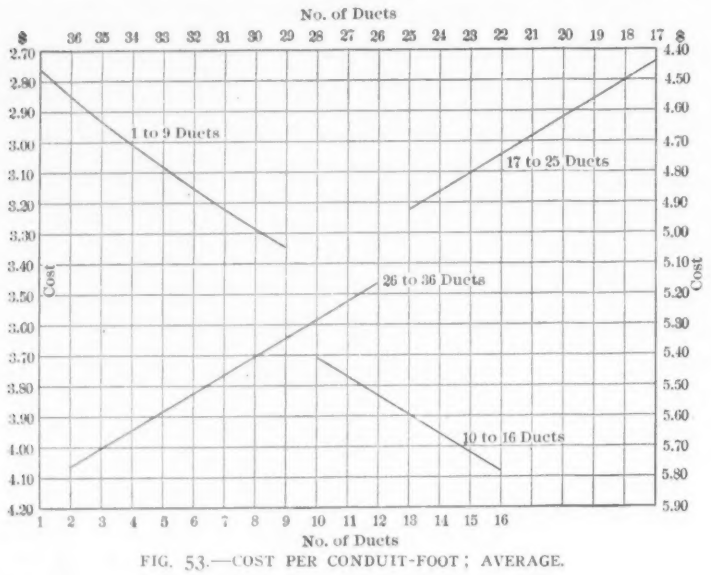


FIG. 53.—COST PER CONDUIT-FOOT; AVERAGE.

habitants or over, where street obstructions are not numerous, and where work can be carried on at usual hours without severe interruption to traffic. Fig. 53 indicates cost in the central portions of similar cities, where obstacles are numerous, and where work must be prosecuted at irregular hours, owing to the impossibility of traffic interruption.

Figs. 54 and 55 are transformations of tables Figs. 52 and 53, showing cost per duct foot, and are the reciprocals of Figs. 52 and 53.

It has been shown that a large proportion of the cost of conduit construction is independent of the number of ducts installed. It is then a pertinent question as to how many ducts can be economically placed in a conduit system when future probable demands are considered. Evidently, if at any future time the conduit system must be increased, the expense of the removal of the paving, excavation and replacement of the street surface must be completely repeated. The cost of the manholes will not need to be reincurred in full, though a certain expense must be allowed to provide for opening the side walls of the manholes and build in the new ducts. If ducts are installed which are not needed for a long period of time, the interest upon the capital invested in their installation, the inevitable depreciation, the cost of maintenance necessary to keep them in good condition will form an annual charge against them. The sum of these items must be contrasted with the cost of opening the street and placing ducts at such future time as will call for increased conduit capacity. If in any instance the probable time elapsing before additional conduit capacity will be needed can reasonably be estimated, the cost of the superfluous ducts placed when the system

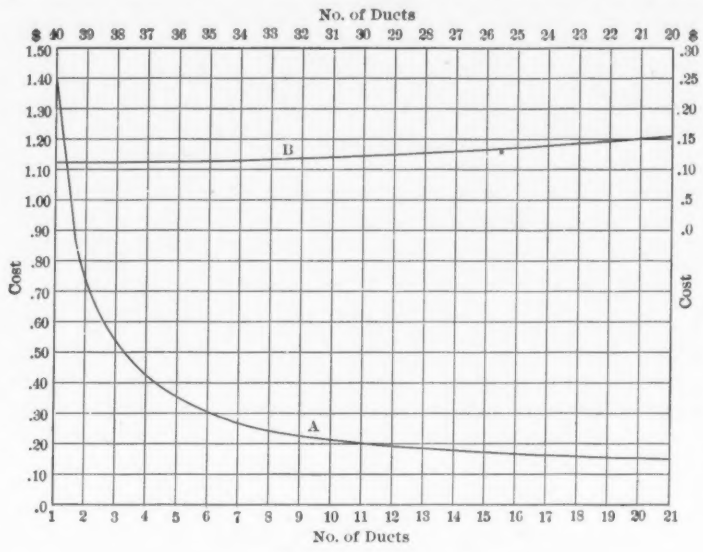


FIG. 54.—COST PER DUCT-FOOT; AVERAGE.

is built, plus the annual charges against them, may be contrasted with the expense of installation in the future, and a decision as to which plan is the more economical reached. To facilitate such calculation attention is directed to Fig. 56. This table shows four

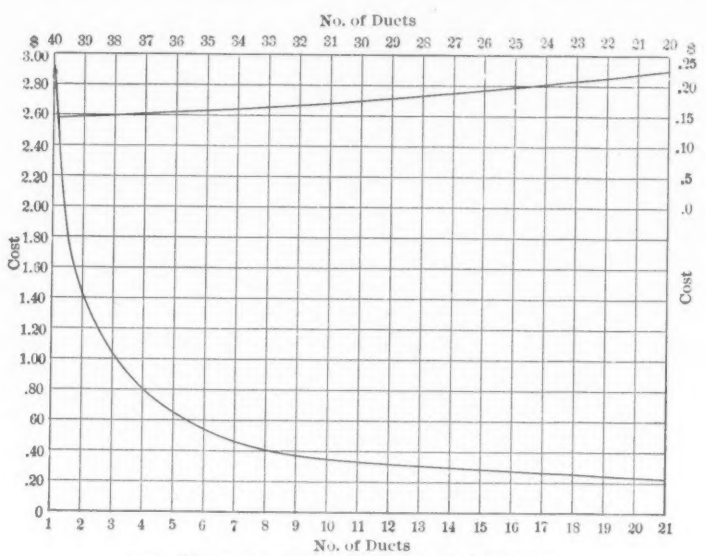


FIG. 55.—COST PER DUCT-FOOT; MAXIMUM.

curves, calculated for varying cost of street paving, from 50 cents to $3.00 per square yard. The horizontal scale gives the number of years, while the vertical scale is devoted to the number of idle ducts. The use of the table is illustrated by the following example:

Suppose a conduit of 16 ducts to be in process of construction, and that it is probable that after a certain lapse of time 20 ducts will be needed. The question arises at once, shall the four additional ducts be placed at the time of original construction, or shall they be left for future installation Assume paving to be worth $2.00 per square yard, and that 20 ducts will be needed before the lapse of four years. Select on the left-hand scale the number 20, and

follow a horizontal line to curve marked $2.00, and a vertical line downward to the horizontal scale, finding 5.6 years. The interpretation of this result is that if the 20 ducts are to be needed sooner than 5.6 years, it will be more economical to install them at the original street opening. But if more than 5.6 years will pass before these ducts will be required, it will be cheaper to omit them and reopen the street when additional capacity is required.

ANNUAL CHARGES.

It is necessary to provide for two kinds of annual expense—Depreciation and Maintenance.

Depreciation.—There is no human device that even with the best possible care will not gradually wear out, and there are few that escape that destructive march of invention that sooner or later renders it necessary to replace old appliances with those of a more modern and economical design.

Depreciation, therefore, is such an annual allowance as will, at the end of the probable useful lifetime of the plant under consideration, provide a sufficient sum to pay the entire cost of complete replacement. It is folly to ignore this charge, for if, owing to a false sense of security, such provision be omitted, the fateful day of reckoning will surely arrive when an empty treasury and a plant that is worn out or obsolete render bankruptcy inevitable. There are many cases in which the permissible rates of depreciation may be simply that necessary to provide for the actual wearing out of the plant, due to natural destructive causes and, in some instances, for example

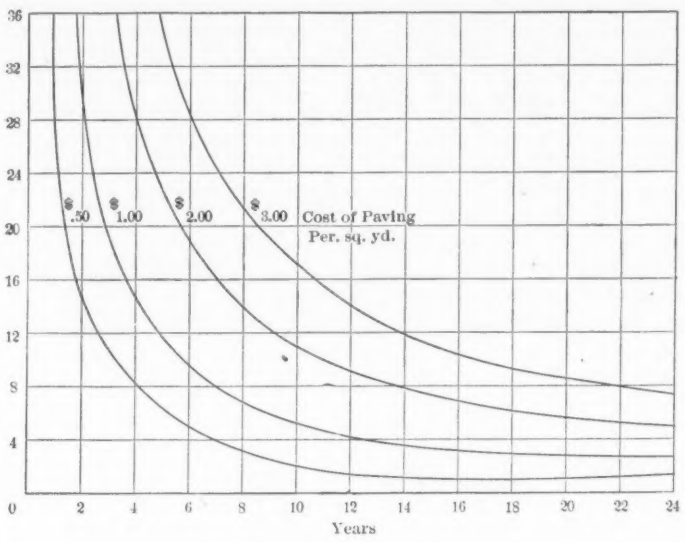


FIG. 56.—NUMBER OF DUCTS.

earthwork construction; the rates may be very low, for such structures are almost imperishable. But with dynamic machinery, which is constantly in operation, where the wear and tear is much greater, higher rates are necessary. In the case of telephone installations, particularly at the present time, a large factor in the depreciation account is the constant improvement in methods and systems which renders the best constructed plants obsolete and valueless long before they are actually worn out. There are few telephone offices in the country that have survived five years without rebuilding, and none that have lived a decade, owing to the very rapid improvements which have taken place in switchboard and substation construction. With the wire plant, life is longer as the rate of improvement is slower, and, in case of underground construction, the plant is on the whole of a durable character.

Depreciation is usually, and most conveniently, expressed as such as annual percentage rate upon the prime cost of construction as will amount at the end of the probable lifetime of the plant to the cost of replacement. Strictly speaking, legal rates of interest on each of the annual amounts set aside should be allowed for the number of years each is held in reserve. But as this refinement adds to the labor of calculation, and as the probable lifetime of plants varies considerably with time and place, sufficient accuracy is usually secured by the simple plan of annual percentage.

As actual experience with underground conduits does not extend over more than a decade and a half, rates of depreciation must be largely estimated. Methods of manufacturing duct material are being improved; competition tends to reduce prices; superior and cheaper methods of street construction all operate to reduce depreciation charges upon subways. Conduits constructed of terra-cotta, in concrete, from all experiences with similar structures, are of great durability. Doubtless, well-burned and well-placed clay laid in first-class concrete would be, if undisturbed, almost everlasting, but even with the best inspection, some defective work will creep in; the constant upheaval of city streets tends to disturb the security of all underground structures, and, finally, there is always a chance of either such improved methods of construction, or the rearrangement of substations as will necessitate the abandonment of existing wireways.

For these reasons 3⅓ per cent. on the cost of main conduit runs, in installations of magnitude, is the lowest advisable rate. For smaller systems, and the branch lines of larger ones, where changes are imminent, 5 per cent. should be allowed, while for lateral ducts, frequently constructed of perishable materials, 10 per cent. is necessary. For conduits of creosoted wood, or other materials more perishable than terra-cotta, from 8 to 15 per cent. for both main and lateral runs should be allowed.

Maintenance.—It is is somewhat difficult to draw a sharp line of demarcation between depreciation and maintenance, for the same charge under one set of circumstances would appear as depreciation, and at another time and under different conditions as maintenance.

Maintenance is best defined as that annual expense which is required to keep a plant in constant uniform running condition, other than that which is chargeable to general decay or the march of invention. For example, the cost of replacing an old rotten pole line is properly chargeable to depreciation, while the expense of rebuilding a new line blown over by a cyclone is maintenance. The cost of removing a line that had been in service, say for five years, should be charged half to depreciation and half to maintenance. The expense of repairs to a switchboard damaged by fire should be charged to maintenance, while the purchase of a new switchboard to replace an obsolete though otherwise serviceable one, is depreciation. Maintenance, like depreciation, is most conveniently estimated as an annual percentage on the prime cost of construction, but no interest can be allowed on maintenance funds, for they are drawn upon from day to day. Theoretically, only such a sum should be appropriated to maintenance as can carry the plant through one fiscal year. If by good luck or good management there is an unexpended balance, it may be returned to general profit and low account, though where estimates are careful, it is wiser to charge such surplus to deferred maintenance, and keep it for that day of misfortune that the Fates always have in store.

An underground conduit would, at first sight, appear to require an almost infinitestimable amount of maintenance, but further consideration reverses this opinion. It is constantly necessary to watch and guard a subway system. Manhole covers are displaced and broken by the impact of passing wheels and must be renewed; vaults must be cleaned out and the masonry repointed and repaired; street paving around vault frames and along the line of the trenches is subject to settlement and must be resurfaced; ever-occurring street excavations tend to disturb and injure conduits and must be watched, and, if necessary, repairs made. Maintenance expense can only be determined as a "factor of experience." For large systems, in favored localities, maintenance may fall as low as one per cent., while in small plants, or under unfavorable conditions, three to four per cent. is necessary.

Adding, therefore, depreciation and maintenance charges the annual expense of large subway systems will be from 4½ per cent. to 5 per cent. for the main runs. For small plants and the outskirts of large ones, from 5 per cent. to 7 per cent. is required. While for ducts of perishable materials from 10 per cent. to 15 per cent. must be calculated on.

Rapid Telegraphy in Hungary.

Despatches from Budapest announce that further improvements have been made in the Pollak-Virag system of rapid telegraphy. Telegrams are now transmitted from Presburg to Budapest, over one wire at the rate of from 50,000 to 70,000 words an hour. A Vienna newspaper describes a dispatch which it received by this process. It consisted of a strip of stiff parchment like paper, bearing 230 words. There was an ordinary dash between the words, which were easily read. The message occupied 15 seconds in transmission.

An Integrating Photometer for Glow Lamps and Sources of Like Intensity.*

BY CHARLES P. MATTHEWS.

IN a previous paper, read before the Institute, I described an equipment designed for the photometric study of arc lamps. The most valuable feature of this equipment lies in its ability to yield a value of the mean spherical luminous intensity from a single photometer setting. It is the purpose of this paper to describe an apparatus possessing this same valuable feature, and several others worthy of note, when used for the photometry of the incandescent lamp and other sources of the same order of brightness.

Designed especially for incandescent lamp measurements, the apparatus has several functions, and might have been styled a "universal glow lamp photometer." It is capable of use for all photometric measurements on the glow lamp that do not lie in the province of spectrophotometry. To particularize, it may be used as follows:

1. As a simple photometer for any unidirectional measurements, such as occur in standardizations, ratings and candle-power distributions.

2. As an integrating instrument for the direct determination of mean horizontal, mean spherical, mean hemispherical or mean zonular candle-power.

3. As an integrating instrument for the direct determination of the spherical reduction factor; that is, the ratio—mean spherical; mean horizontal candle-power.

The fact has long been recognized that the only strictly fair basis for the comparison of incandescent lamps is that of the total flux of light emitted, a quantity proportional to the mean spherical candle-power. It is possible by altering the configuration of the filament to concentrate luminous flux in particular solid angles at the expense of flux in other angles. Hence, two lamps of equal rated candle-power may yield total light flux in quite different amounts. On the other hand, if two lamps have initially the same mean spherical candle-power, their relative value is determined simply by their power consumption and sustained candle-power. The vexed question of what is the most useful light may well be left to the purchaser, who can select the type of filament best adapted to his own needs. The question is comparable to that which asks: What is the best diet for man?

Of the methods in use in the determination of the mean spherical candle-power, the most accurate is that in which measurements are made at equal angular intervals through 180 degrees in a plane passing through the axis of symmetry of the filament, the lamp being rotated meanwhile about this axis. From the readings so obtained, the mean spherical value may be found either by formula or the graphical construction known as the Rousseau diagram.

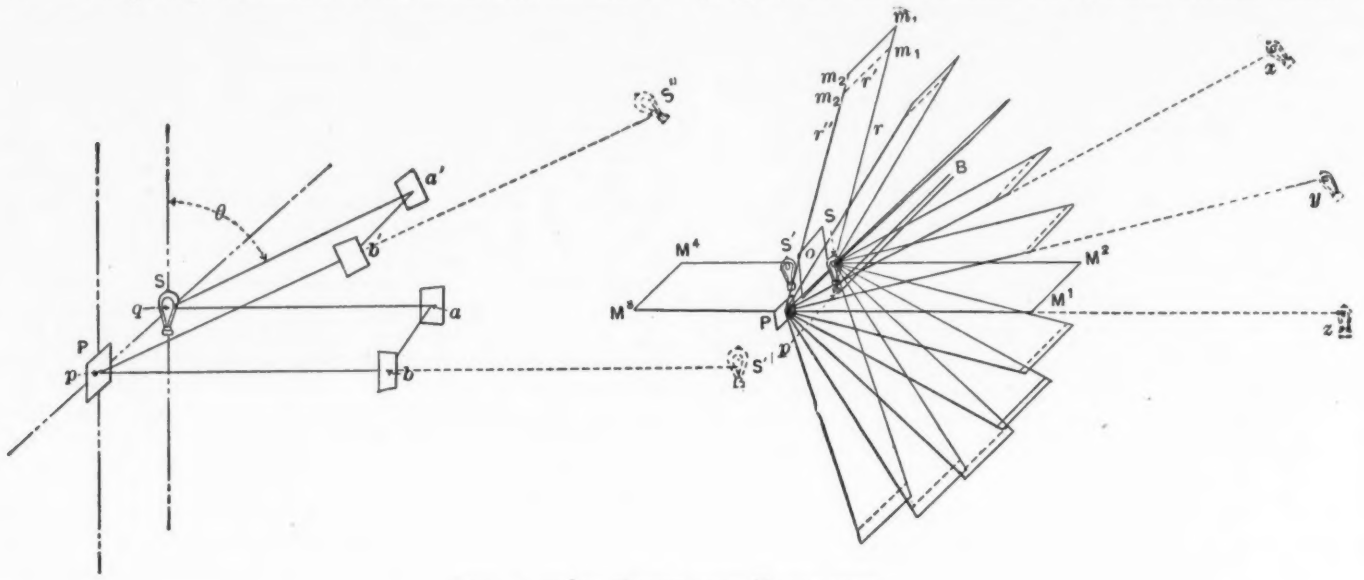
The method employed in the Franklin Institute tests of 1884 involes the mean of 38 candle-power values taken in such directions as to give a nearly uniform space distribution. The mean of these values is the result sought.

Both of the foregoing methods involve a large number of readings—so large, in fact, that their application to the practical rating or extended study of lamps is out of the question.

A third method consists in the use of the spherical reduction factor appropriate to the type of filament under consideration. Unfortunately, this factor is not a constant for any given type of lamp. With some types, the method yields a good result; with others the variations are such as to render the results only roughly approximate. A disadvantage is the large and increasing number of types on the market and the necessity for determining and keeping account of the corresponding constants.

Liebenthal found as the result of an extended series of measurements that the mean of the intensities taken at 51.8 degrees north polar distance and 51.8 degrees south polar distance on a spinning lamp is a value approximating the mean spherical intensity, regardless of the type of lamp. The errors resulting from the application of this method range from —.1 per cent to + 3.9 per cent. This is probably the most accurate of the simpler approximative methods.

From what has been said, it would appear that there is need of a photometer capable of giving the mean spherical candle-power of an incandescent lamp with the ease and celerity obtainable in the ordinary photometric measurement. With this need in mind, I have designed and had constructed the apparatus descibed below.



FIGS. 1 AND 2.—INTEGRATING PHOTOMETER.

The theoretical basis of the design is the approximate equation for the mean spherical intensity,

$$I_{ms} = \frac{\pi}{2n} \sum_{0}^{\pi} I_{\theta} \sin \theta \qquad (1)$$

wherein I_{θ} is the intensity of a ray making an angle θ with a vertical passing through the light center and n the number of terms in the summation. In order that equation (1) may apply to a glow lamp, it is necessary to spin the lamp precisely as is commonly done in determining mean horizontal candle-power.

To see how equation (1) may be made the basis of an integrating photometer, let us consider a source of lights (Fig. 1), and a photometer screen P, whose plane extended contains the effective light center of S. We will hereafter denote the center of the photometer screen by p, and the effective light cente by q. For convenience we will further assume that p and q lie in the same horizontal plane, to which the plane of P is normal, and we will call the line pq the axis of the system. Now consider two mirrors whose planes are vertical and make an angle of 90 degrees with each other. Let the centers of these mirrors, designated by a and b, come into the horizontal plane in such positions that the lines qa and pb are equal and respectively normal to the axis of the system. Let a' and b' be the centers of a second pair of mirrors occupying a position such as would be found by swinging a and b, without mutual displacement, upward about qp as an axis until qa makes the acute angle θ with the vertical. Having thus located a' and b' angularly, we may now assume that some radial movement of this pair of mirrors is possible. The eye placed at p will see virtual images of the source in horizontal and θ aspects, respectively. The images s' and s''

* A paper read at the October meeting of the American Institute of Electrical Engineers.

may be regarded as producing jointly an illumination on the photometer screen of

$$i_0 + i_\theta = \frac{K_0 I_0}{d^2_0} + \frac{C K_\theta I_\theta}{d^2_\theta} \qquad (2)$$

where K_0 and K_θ are the reflection coefficients of the pairs of mirrors, d_0, d_θ, the distances from source to screen by way of the mirrors, and C a factor varying with the incidence of the light upon the photometer screen P. Now if n pairs of mirrors be placed similarly to a, b and a', b', but spaced at equal angular intervals of $\Delta\theta$ such that $n\ \Delta\theta = \pi$, we shall have as the resulting illumination

$$\sum_0^\pi (i) = \sum_0^\pi \frac{C K_\theta I_\theta}{d^2_\theta} \qquad (3)$$

If by radial adjustment of the mirror pairs we make

$$\frac{C K_\theta}{d^2_\theta} = \frac{K_0 \sin\theta}{d^2_0} \qquad (4)$$

then

$$\sum_0^\pi (i) = \frac{K_0}{d^2_0} \sum_0^\pi I \sin\theta \qquad (5)$$

That is to say, the total illumination of the screen is proportional to the mean spherical intensity of the source. (See equation 1.) To evaluate this intensity, it is necessary merely to balance this illumination against that due to a source of known intensity at a known distance.

Fig. 2 shows the disposition of twelve pairs of mirrors, m_1, m_2, etc., in order to produce the desired results. If the illumination of a given surface varied exactly as the cosine of the incidence of the light upon that surface, and if all mirrrors used were of equal reflecting power, then there would be no need of radial adjustment of the mirror pairs, for in such case $S\,C = \sin_\theta$ and $K_\theta = K_0$. But the so-called cosine law is only approximately true, and mirrors vary in reflecting power, hence it is necessary to compensate for discrepancies in C and K_θ by slight changes in d_θ. The extent to which this correction is of importance depends, of course, upon the nature of the photometer screen. The plaster of Paris surface of the Lummer-Brodhun screen obeys the cosine law with exactness up to an incidence of 50 degrees, but beyond this point a divergence of increasing magnitude occurs (Fig 3). Hence, for the Lummer-Brodhun screen the only adjustment of mirrors necessary is that to overcome variations in their reflection coefficients, except for angles greater than 50 degrees. With mirrors cut from one sheet of glass, the correction for variation in reflecting power is often negligible.

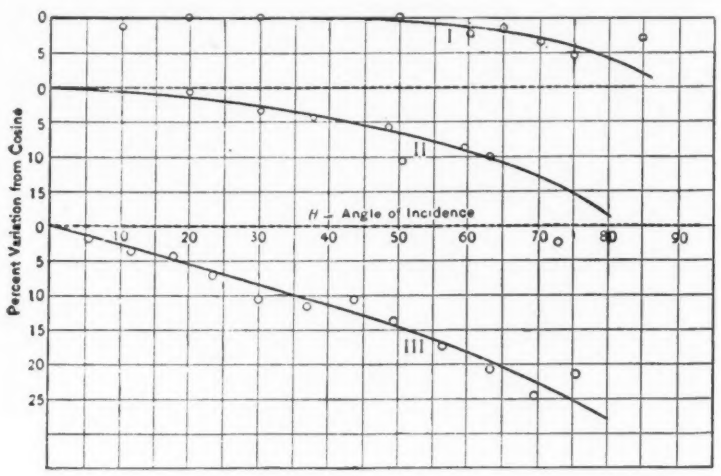


FIG. 3.—VARIATIONS FROM COSINE LAW.

With the Bunsen screen, correction must be made for all angles of incidence. For example, the second curve in Fig. 3 is the result of measurements made upon ordinary draughting paper, from which the Bunsen screen is often made. Here the departure from the cosine relation is noticeable from the very beginning, and becomes as high as 15 per cent. at 75 degrees incidence. The third curve in the same figure shows the results obtained with ordinary glazed writing paper. The cosine relation is not even roughly approximate in this case.

Fig. 2 also shows the method of balancing the illumination produced by the series of images, due to the circular system of mirrors. The curves show the percentage of variation from cosine relation for different screens; Curve I, referring to the Lummer-Brodhun screen; Curve II to a screen of unglazed paper, and Curve III to a screen of glazed paper Mirrors M_1, M_2, M_3, M_4 are cut from one piece of glass, just as are the mirrors in the ordinary Bunsen photometer. It is not essential that the other mirrors of the system should have the same coefficient, since, as already explained, the initial adjustment corrects for failure of the cosine relation and inequalities in the mirror coefficients at the same time. With the standard at s′ separated from s, the source to be tested, by an opaque screen, a balance in the illumination is obtained by moving M_3 and M_4. The method of doing this will be better understood by reference to Fig. 4 which shows in elevation and plan the essential elements of the ap-

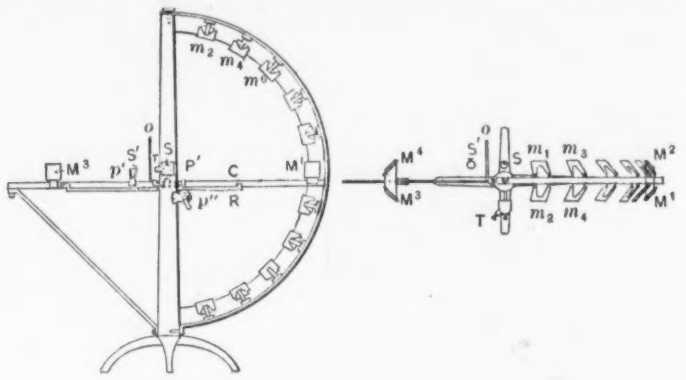


FIG. 4.—ELEVATION AND PLAN OF APPARATUS.

paratus. To the right of these figures is seen the mirror system, each pair of mirrors being capable of a certain amount of radial movement for purposes of the initial adjustment of the instrument. s is the lamp to be tested, mounted upon a rotator, s′ is a standardized glow lamp. The mirrors M_3 and M_2, rigidly connected, may be moved along the bar by means of a rack and pinion conveniently under control of the observer at the photometer P. The photometer is fixed, and hence the operation of making a setting is more convenient than that which obtains with the ordinary sliding form. As the design is based upon the approximate equation (1) and not upon the integral form, some error arises from this cause. With eleven pairs of mirrors the error is negligible for all practical purposes.

Fig. 5 shows a photograph of the finished apparatus with all screens removed, in order that the details of construction may be better seen. This particular instrument is fitted with a Lummer-Brodhun photometer screen. Each mirror bracket is povided with two pins. These pins extend through the frame of the ring radially. By means of this construction, each mirror pair may have independent radial adjustment.

We will now consider in detail the different operations to which the instrument readily lends itself.

Operation 1.—Measurement of Mean Horizontal Candle-Power.—In this operation the apparatus is used as a simple photometer. Hence, all mirrors except the four horizontal ones are covered by black screens suitably provided for the purpose. The right pair of mirrors (Fig. 4) is connected at C to the sliding rod carrying the rack. The lamp, s, to be tested is mounted in the rotator and driven at a speed of, say, 180 r. p. m., and a standardized incandescent lamp, of intensity $I_{s'}$ is placed in a suitable holder, at s′. The rod R may be moved by the hand for a rough adjustment, and the pinion P″ used only for the final setting. Since a displacement, d, of the mirror pairs means a change in the light paths of $2d$, the moving rod is graduated in divisions one-half the unit (centimeters) in which the light paths are conveniently measured. A reading, R, means that the distance from s′ to the screen by way of the mirrors M_3, M_4, is R centimeters. If now the total photometric distance between the sources is 300 cm, we have for the intensity I of the light under test,

$$I_s = \left[\frac{300 - R}{R}\right]^2 I_{s'} \qquad (6)$$

$$= T_1 I_{s'} \qquad (7)$$

where T_1 is the value of the expression in brackets and stands for "tabulated value corresponding to the reading R." When the apparatus is used with a standard of always the same intensity, it is a simple matter to make the instrument direct reading.

Obviously, the mean intensity in any north or south polar zone may be found by clamping the arm of the rotator at the proper angle and spinning the lamp, readings being taken as for the mean horizontal measurement. The mean horizontal candle-power of a flame

source must be found by taking the horizontal distribution stepwise, since it is impracticable to rotate such a source. Equation (7) is applicable in such measurements.

Operation 2.—Distribution of Candle-Power in Vertical Planes.—The distribution of intensity of an incandescent lamp in any vertical plane is obtained with the apparatus arranged as described under Operation 1. The arm of the rotator is merely tilted about a horizontal axis so as to bring any desired aspect of the lamp toward the photometer screen. From equation (7) the different intensities are easily found.

The vertical distribution of candle-power from a flame source cannot be obtained by tilting the arm of the support. The following method is available in such cases: Mount the burner vertically at s; disconnect the mirrors M_1, M_2 from the movable rod and push them to their place at the extreme right (Fig. 4). Now with a

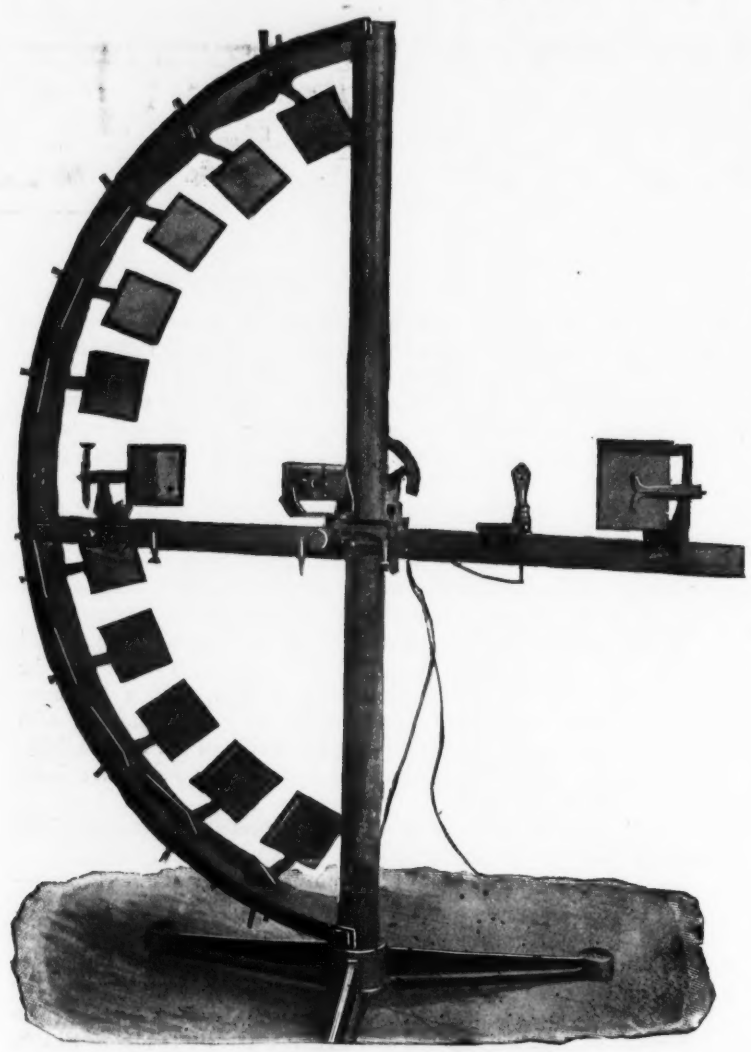


FIG. 5.—GENERAL VIEW OF APPARATUS.

standard of the same order of brightness as the source to be tested, make a setting. The horizontal intensity is given by

$$I_0 = \left[\frac{200}{R}\right]^2 I_{s'} \qquad (8)$$

$$= T_2 I_{s'} \qquad (9)$$

where T_2 is the tabulated value of the expression in brackets corresponding to the reading R.

To obtain the intensity of the source in a direction of θ_0 to the vertical, the horizontal and θ mirrors should both be used. This prevents the limit of the bar being reached by mirrors M_3, M_4. The intensity is given by

$$I_\theta = \frac{T_2 I_{s'} - I_0}{\sin \theta} \qquad (10)$$

where I_0 is the intensity found in the horizontal measurement.

Operation 3.—Standardization of Glow Lamps.—For this operation the lamp, s, is removed and a horizontal circular plate mounted in place of the lamp. This plate is ruled with concentric circles, which facilitate the centering on the amylacetate lamp or other primary standard. The lamp to be standardized is mounted at s′. With all mirrors screened except the horizontal ones, and with M_1, M_2 attached to the bar, settings are made as usual. The value of s′ is given by

$$I_{s'} = \frac{1}{T_1} \qquad (11)$$

if the standard is unity.

Operation 4.—Measurement of Mean Spherical Intensity.—(*a*) *Glow Lamp.*—The lamp to be tested is mounted in the rotator and driven at a speed of about 180 r. p. m. Mirrors M_1 M_2 are detached from the movable rod and pushed to the extreme right, in which position they may be considered a part of the system of eleven mirror pairs. With a standardized lamp at s′, a setting is made in the manner already described. If R is the reading, we have

$$I_{ms} = T_3 I_{s'} \qquad (12)$$

where T_3 is a tabulated value corresponding to the setting R and $I_{s'}$, the intensity of the standard as heretofore. Thus the operation has all the simplicity of any photometric measurement.

The intensity of the standard used should be approximately that of the lamp to be tested. For example, if a 16-cp lamp is to be tested, a standard of not less than 16-cp is best. With such a standard, the range of possible measurement depends upon the limit of travel of the mirrors M_3 M_4. A 16-cp lamp will serve as a standard for the measurement of mean spherical intensities ranging from 2 to about 25 cp, when the limit of travel is about one meter. It is best to substitute a 32-cp standard for intensities much greater than 16 cp.

(*b*) *Flames.*—To obtain the mean spherical intensity of a flame or of any source that cannot be rotated, it is necessary to repeat Operation 4 at equal angular intervals on the horizontal circle. The mean of the results may then be taken.

Operation 5.—Direct Measurement of the Spherical Reduction Factor.—If the standard s′ and the opaque screen o be removed, it is clear from the figure that the left side of the photometer screen will be illumined by the horizontal rays of the lamp s. In fact, if s be rotated, we will have on the right side of the photometer screen an illumination proportional to the mean spherical intensity of s, and on the left side of the screen an illumination proportional to the mean horizontal intensity of the same source. Under these conditions the photometer setting yields the spherical reduction factor. In other words, the mean spherical intensity is measured against the mean horizontal intensity as a standard. The reduction factor is given by

$$f = T_3. \qquad (13)$$

As the removal of the standard s′ lengthens the distance from source to screen, it is necessary to add a constant to the reading. This is provided for by a second reading point, marked R F. All readings for Operation 5 must be taken at this reference mark.

Operation 6.—To Check the Horizontal Mirror Constants.—As before stated, it is essential that the four mirrors attached to the movable bar should have the same constant. To ascertain if this condition exists, remove the opaque screen and the lamp s′, as in Operation 5. Connect the horizontal mirrors to the moving rod and, screening all other mirrors, take reversed photometer readings on a rotating lamp s. If the mirror coefficients are equal the mean reading will be 150, indicating equal light paths on each side of the photometer screen. Here again the R F reading mark must be used.

Operation 7.—To Check the Adjustment of the Circular Mirror System.—In case of any doubt as to the accuracy of the initial adjustment of the photometer, or in case of the substitution of a new screen, it may be necessary to readjust the mirrors of the half ring. This operation is best performed as follows: Mount at s a 32 nominal cp lamp, and at s′ an 8-cp lamp, the latter being in circuit with a rheostat capable of continuous variation. With mirrors M_1 and M_2 free from the moving rod, and with all other mirrors on the half ring screened set R equal to 100 cm. Now, while maintaining the 32-cp lamp at constant voltage, vary the voltage impressed on the 8-cp lamp until the photometer shows equal illumination. Note voltage on 8-cp lamp. Repeat measurements with reversed photometer. The lamp should finally be maintained at the mean voltage so found. Under these conditions the two lamps have a candle-power ratio of 4:1. Next tilt the lamp holder to an angle of 15 degrees. Uncover the corresponding mirrors ($\theta = 75$ degrees or $\theta = 105$ degrees) and cover the horizontal ones. Under these conditions we

have the same aspect of the lamp toward the photometer, but with the light incident at 15 degrees. Set the bar at

$$R_{15} = \frac{R_0}{\sqrt{\cos 15^\circ}} \qquad (14)$$

Adjust the 15 degree mirrors radially until an equality of illumination is obtained, then secure them by means of the set screw. This operation may be repeated until all the mirrors have been adjusted.

Electrical Equipment of a Smelting Plant.

About three miles from the town of El Paso, Texas, are located the smelting works of the American Smelting and Refining Works, known as the El Paso Smelting Company. This new plant, which is one of the largest in the country and, perhaps, the best equipped in the world, takes the place of an old smelter burned down in the summer of 1901, the ashes of which were hardly cold before the plans of the new and far superior plant were begun. Although second in size and capacity, the plant covers not more than nine acres. Not a foot of space has been wasted, although the matter of convenience and room for working is plainly shown in every detail.

Approaching the plant from the El Paso side, the first thing to attract the eye are the four smoke stacks of brick, and the fortified appearance given it by the 3,000 feet of flue brick walls on the south and west sides. The steep rock hills on the east side adds to the fort-like appearance of the works. The capacity of the plant at the present is about 50,000 tons of ore per month, and it is capable of large expansion. When the plant is running at full capacity it employs about 1,000 men.

The buildings consist of blacksmith shop of cream-colored brick, a small steel building for copper and tin shop, a few short steps from which is found the power house of brick, having a steel roof and iron floor. North from the power house is the furnace building, which, as it now stands, is 240 feet long, and material has been ordered for extending it 36 feet further. This structure is of steel throughout, and here are placed the nine furnaces—seven for lead and two for copper—with space for two more.

On the south side of the furnace building are large ore and coke bins, with elevated tracks where freight cars can be run and conveniently loaded. The next building on the south is the sampling works, which is also steel, and fitted out with smaller roller mills. In the northwestern portion of this structure is the assay office. Southwest of this comes the low steel structure where the 14 roasters are found. Down by the river a pumping plant is located, which elevates the large amount of water necessary for the use in the plant and in the small town which surrounds it.

From the finely equipped power house electric power is transmitted to every part of the plant, pump house and for lighting the plant and town. In this building are four large Corliss engines, of the compound condensing type; two General Electric motors, of 500-kw capacity, and two motors of 75-hp, and one 2,000-light dynamo. All or very nearly all, of the machinery is directly connected—the exceptions being that operated by small motors.

The boiler room contains six 150-hp tubular boilers of high pressure, space being provided for two more of the same type, or for one of a larger type tubular that is being considered. The pump room contains large hydraulic pumps for the elevator service used about the furnace room for moving the elevator that lifts the ore, coke, fluxes, etc. This room also contains the fire pumps to be used in case of fire. These are in duplicate; in case of failure of one or more, there are others to be called into service. Here also are the large water pumps for supplying and forcing water to the reservoirs in different parts of the plant and town. These pumps are also in duplicate and direct connected to electric motors.

The sole fuel used in the plant for power development purposes is Beaumont oil. The oil for the boilers is supplied from a storage tank of 75,000-gallon capacity, sunk beneath the ground.

All the machinery in the entire plant, including pumps at the river, are driven by electric motors, no steam being used except in the engine room. All of the power plant given above except the pumping plant at the river is under one roof, a building of cream-colored brick with a steel roof and iron floor, and absolutely fireproof.

All the material, such as coke, the charges of ore and fluxes, is carried to the top of the furnaces by electric cars of eight-tons capacity each, using the third-rail system. These cars are loaded from beneath the freight cars from a convenient system of bins, taken thence to the hydraulic elevator and again by electric power through a system of switches to any designed hopper, automatically dumped and returned.

Wherever electricity can be used, electric motors have been installed. Every detail as to economy of space, labor, energy and money has been thoroughly planned and scientifically put into practice. Every building has been made absolutely fireproof, and another disaster, like that of last year, can never fall on the present plant.

Much credit is due to F. C. Earl, manager, and his assistants, F. S. Austin, superintendent, and J. J. Omsby, assistant, for the masterly way the construction of the plant was handled. This establishment is at the head of many similar plants now owned by the American Company in point of size, new and modern machinery, and is the leader in labor and time-saving devices.

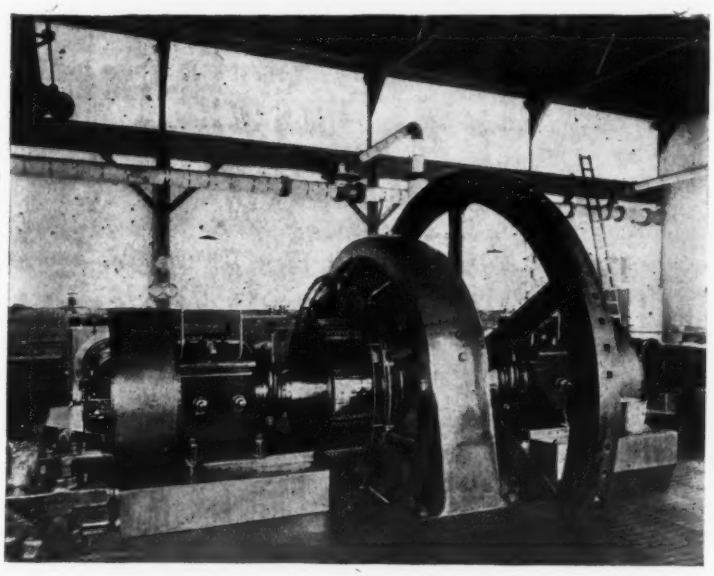


FIG. 1.—500-KW GENERATOR.

FIG. 2.—ELECTRIC ORE CHARGER.

Annual Report on United States Signal Service.

The annual report of Gen. A. W. Greely, Chief Signal Officer of the army, says the corps have actually built and put in working order in Alaska 1,121 miles of land lines and submarine cables within a period of 24 months. The accomplishment of such results, he says, would be most creditable to officers and men concerned therein if Alaska was an ordinary country, for this work included not only surveying, construction and installation of this length of line, but also involved the manufacture and inspection of enormous quantities of material, instruments, etc., many hundred tons in weight, and their transportation over distances ranging from 4,000 to 7,000 miles. When one considers, however, the exceedingly difficult physical conditions within the Territory, he says, the work must be considered simply phenomenal, as in all parts of Alaska traversed by this great length of line there are not a dozen miles of wagon road and much of the region is unexplored.

Speaking of improvements effected by the corps in Cuba, Gen. Greely says: It is unquestioned that on occupying Cuba the American army found a few dilapidated telegraph lines, operated by antiquated methods, with tariff rates increasing in proportion to the length of the message without free delivery, and with grave uncertainties as to espionage, secrecy and delivery. This system, bad as it was, served only the western half of the island. In leaving Cuba, there was turned over to the government a system of 3,500 miles, extending from San y Martinez in the west to Cape Maysi in the extreme east, with every seaport or town om importance electrically connected. The present instruments are of the best modern types, the transmission speedy and reliable, and the tariff rates exceedingly low, while the certainty of delivery and inviolability of messages are beyond question.

Of the work in the Philippines, the report says: The magnificent system of telegraph lines and cables was very largely constructed and installed under Col. Allen. This system, increased during the fiscal year by 2,600 miles, consisted on June 30, 1902, of 31 submarine cables, 1,326 miles in length, and land lines 5,108 miles in length, making an aggregate of 6,434 miles. It is almost needless to say that the work of construction and installation, under the disturbed and difficult conditions existing in the archipelago demanded talents of the highest order. The system stands to-day a monument to the energy, skill and resourcefulness of the American soldier. On entering the Philippine Islands, the American army found practically no existing telegraph lines, as the few land lines connecting the Visayan cables of the Eastern Extension Telegraph Company had been promptly destroyed by the insurgents, as well as the lines in Luzon, when they retired before the advance of our army. The only lines of any importance that came into our possession were several hundred miles of dilapidated and antiquated lines in the Cagayan Valley, and along the west coast of Luzon.

Gen. Greely calls attention to the necessity of a Pacific cable. Owing to the great pressure of work, he says, not as much time has been given to wireless telegraph tests as Gen. Greely desired, but he reports that progress has been made. He again calls attention to the necessity for international cables regulations, and recommends that the War Department be represented at the international telegraph conference, to be held in London next year.

Electricity for North Pole Expedition.

Capt. Bernier, who is organizing the Canadian North Pole expedition will take with him two of the latest improved windmills to be used in driving machinery in the ship workshop, and a dynamo for electric lighting. A London firm has sent Capt. Bernier an equipment of the latest appliances for use in the electric treatment of any diseases that may develop among the members of the expedition while in the Arctic regions.

Dogs on Paris Underground.

The crusade of dog lovers for transportation of their best friends by the Metropolitan lines has bobbed up again, and the management of the underground road, at last touched by the appeals of dog owners, seriously contemplates placing on cars in which the inseparable master and dog will be allowed passage.

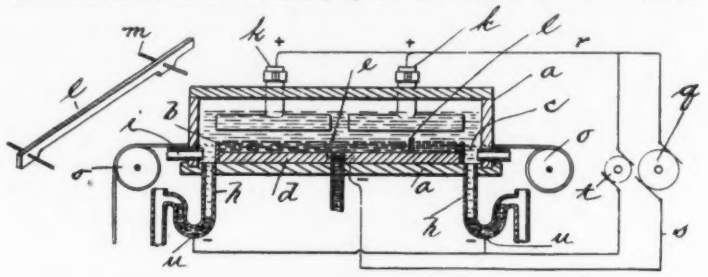
Recent Electrochemical Developments.

By Clinton Paul Townsend.

MERCURY CATHODE CELL.

Mr. Arthur E. Truesdell, of Pittsfield, Mass., clearly states the conditions which govern the reoxidation of sodium in the electrolyzing compartment of a mercury cathode cell, and suggests an ingenious construction for minimizing the losses from this source. Sodium set free upon a quiescent cathode of mercury at the limiting surface of an electrolyte does not readily diffuse through the body of metal, but the lighter amalgam forms a surface layer which tends to react with the electrolyte. Mr. Truesdell proposes to remove the amalgam as rapidly as possible from the surface of the mercury; to restrict as far as possible the area of its contact with the electrolyte; and to further check its tendency to solution by a supplemental cathode connection to the amalgam at its contact surface. He states also that the fresh brine is a less energetic oxidant for sodium than the spent solution, and prefers therefore to introduce the brine at or near the point of withdrawal of the amalgam.

The disposition of parts will be clear from the accompanying diagram in which the mercury cathode, *e*, rests upon the conducting base, *d*, of the cell, *a*, anodes, *k*, lying in the electrolyte above its surface. Lateral ribs, *b*, projecting from the base of the cell determine the limits of the cathode, and the surface amalgam formed upon the mercury is caused to flow over these ribs into the outlet traps, *h*. A sweep, *l*, is caused by means of appropriate cords and pulleys, *m*, *o*, to reciprocate in the mercury, whereby the amalgam is flooded into the lateral channels, *c*, between the ribs, *b*, and the sides of the cell. The bottoms of these channels, *c*, are inclined in either direction



TRUESDELL MERCURY CATHODE CELL.

to the outlet trap, *h*, so that the amalgam will flow directly into the latter, and its contact surface with the electrolyte will be reduced to the cross sectional area of the trap. Further protection is afforded by a supplemental cathode connection, *u*, from a secondary current source, *t*, whereas the main electrolyzing current comprises the dynamo, *q*, and the lead wires, *r*, *s*.. The fresh brine is introduced through pipes, *i*, into the lateral channel, *c*, immediately over the amalgam traps.

ELECTRICALLY PREPARED FERTILIZER.

The applications of electricity to a preparation of fertilizers have been limited hitherto to the treatment of insoluble phosphates for the purpose of increasing their proportion of available acid, or of separating such iron as they may contain. It is now proposed by John J. Crooke, of New York, to treat the deposits of peat and analogous accumulations of matters rich in humus which occur in bogs and salt marshes, with the object of producing therefrom a fertilizer, or better, a soil dressing; for humus is hardly to be classed as a plant food.

The process consists in subjecting "sour" humus to electrolysis for some hours between electrodes of iron, under current conditions not fully defined. The chemistry of this would be sufficiently obscure even without the singular statement that hydrogen, hydrogen sulphid, carburetted hydrogen, and chlorine, are liberated together at the anode. Freshly dug peats, like all bodies of strong reducing properties, are inimical to agricultural plants; they are also germicidal and hinder those processes of nitrification which are so essential to fertility. Further, many peats are positively poisonous, owing to their content of sulphid of iron. Exposure to air and weather corrects these defects, and it would not be surprising if electrolytic oxidation should prove equally effective.

METAL COATINGS BY ELECTROLYSIS.

Electrolytic metal coatings, especially those deposited at moderate or high current densities, are usually of somewhat loose texture. An

obvious remedy is a mechanical compacting device, and such have met with a measure of commercial success. For the production of metal tubes or of sheets upon mandrels, the elaborate burnishing tools of Elmore and of Kugel, are effective, and for small articles the tumbling drum is in common use. In the latter case the compacting or polishing effect is attained through the mutual contact of similarly coated particles. Mr. C. J. Reed, of Philadelphia, claims that superior results may be reached by the action of a non-conducting granular polishing material, such as sand, the polishing action on the metal coating being secured by the movement of the negative or plated electrode. In the simplest embodiment of the invention, the mandrel or article to be plated is revolved, or given a circular movement, in a mixture of the electrolyte and the abradant. For small articles the tumbling drum is employed, sand being mixed with the articles, and the latter plated intermittently during their periods of contact with the cathode.

New Telephone Patents.

Last week five more telephone inventions were presented in the patent issue, that of October 28. Of these, one issued to R. Gaillard and E. Ducretet, both of Paris, France, is of especial interest, as it seems to indicate a possible repetition of a past difference in European and American practice. The invention is what may be called a multi-circuit-granular transmitter. Some years ago European standard transmitter practice, or rather European universal transmitter practice, for there was no European standard, provided several parallel microphonic circuits, while in America but one such circuit was ordinarily used. This difference in practice was largely done away with by the introduction of the granular carbon transmitter. Now comes from Europe this multi-circuit granular carbon transmitter, which bears the same relation to our single-chamber granular transmitters as did the old muliple-circuit microphones to the single-contact transmitter.

Fig. 1 shows the transmitter of Messrs. Gaillard and Ducretet, being two sectional views taken at right angles to each other. The rear or stationary electrode is corrugated, and across the corrugations are cut a number of slots. The stationary electrode is surrounded by a ring of elastic fabric, and the slots carry strips of the same material, so that the transmitter is divided up into a number of long narrow compartments. Each of these is filled with granules of carbon, and the whole is so covered by the diaphragm that the granules of the various compartments are kept distinct. It is claimed by the inventors that this transmitter is adapted to currents of large volume. It will be interesting to note in what light foreign engineers will consider this transmitter.

A further telephone transmitter invention of this issue is that styled a "sound concentrator." This is an appliance for transmitters used with instruments for the deaf. It consists of a cup-shaped vessel, near the mouth of which a transmitter is so mounted as to leave an annular opening, the diaphragm of the transmitter facing the bottom of the cup. The periphery of the bottom of the vessel is so rounded or inclined, and the middle of the bottom is so raised,

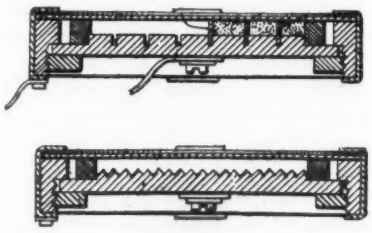


FIG. 1.—GAILLARD AND DUCRETET TRANSMITTER.

that all sound entering the annular opening will be concentrated by reflection upon the center of the diaphragm.

Two patents, issued to David S. Hulfish and assigned to the American Bell Telephone Company, represent the component parts of a divided original application, and they are so mutually involved that for convenience they will be recombined in the following description: The invention provides a common-battery subscriber's line circuit, such that the stations of a party line may signal and communicate with each other without involving the central office operator; and it also provides that while the stations are so communicating the line will be protected from incoming calls.

Fig. 2 shows Mr. Hulfish's complete circuit. At the right are three subscribers' station, S, S^2, S^3, while at the left is the corresponding line apparatus at the central office. There are two kinds of calls to be considered, those for other lines and those for stations of the same line. In the case of the calls for other lines, it will be necessary only to consider the operations in detail through the notification of the operator.

Suppose station S^3 originates the call, he first removes his receiver from the hook, and, ascertaining the line not busy, he depresses his left-hand push key until he hears the operator answer. Observing the drawing, it will be noticed that when the receiver was removed from the switch, the latter in rising closed the bridged circuit con-

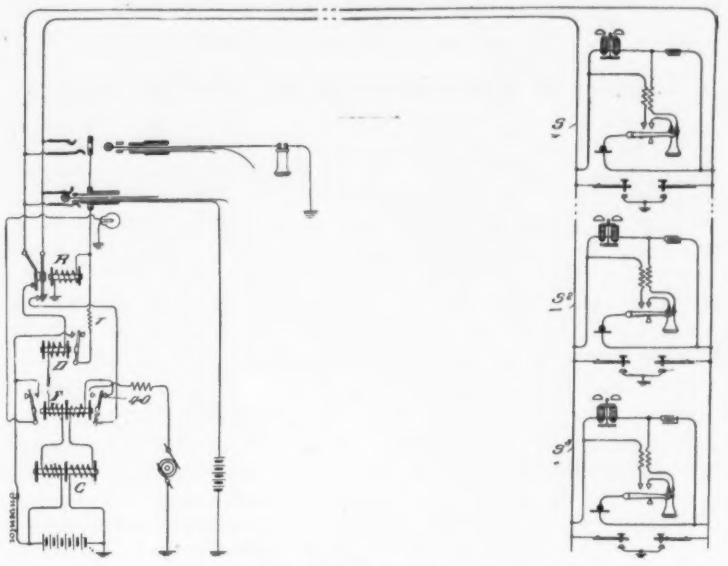


FIG. 2.—HULFISH BUSY TEST SYSTEM.

taining the telephone instruments. Current from the central office battery thereupon flowed through the windings of the retardation coil, G, and through the relays F and D. Relay F fails as its windings are differentially connected. Relay D, on the other hand, operates, but this is incidental only, and this operation has at this time no useful function. Subscriber S^3 now depresses his left-hand key, and thereby grounds the corresponding side of the line, virtually short-circuiting one of the windings of relay F. This relay therefore operates under the influence of its non-short-circuited coil, closing the line-lamp circuit. The relay F also at this time connects the grounded ringing generator to one side of the subscriber's line, but as this is the side that is grounded by the depression of the push key at S^3, no effect is produced on the bells at the various stations, nor on the receiver at S^3. When the operator answers the insertion of her plug in the line jack operates the cut-off relay, removing the relays and signals from the circuit in the usual manner.

If subscriber S^3 had desired a station on his own line, such as station S, after having ascertained that the line was not busy he would have returned the receiver to the hook, thereby opening the bridge on the line and removing the current from all relays. He would then depress his right-hand push key a number of times to correspond exactly with the code signal or ring of station S. The depressing of this key grounds one side of the line, as did the other key, but it is the opposite side from that previously grounded. This completes the circuit of one coil of the relay F, which operates as before, flashing the line lamp once for each depression of the key. The operator ignores these flashes, being instructed to respond to a steady light only. At the same time relay F connects the ringing generator to the line, this time to that side which is not grounded. The bells at the stations of the line, therefore, do respond and ring the code signal corresponding to the number of depressions of the key at S^3. Station S only responds, as it was his signal which S^3 sent. After he has responded and S^3 has also removed his receiver from the hook, the transmitter current for both is supplied through the retardation coil and relays. Relay F is at this time unoperated, but relay D is operated, and with the result that battery is connected to the sleeves of the jacks through the resistance r. This resistance is the true key to the situation, for it is of such size that while a sufficient busy test potential is provided, there is not enough current flowing to operate the cut-off relay.

The fifth and last patent to require mention is that granted to Geo. T. Newman, and termed a "telephone attachment." This device consists of a polarized bell and special switch, so wired to two telephone lines that one subscriber's set may be used interchangeably on the two lines. Simultaneously with the transfer of the subscriber's set from one line to the other the extra magneto-bell is transferred, but in the reversed direction so that each line always has one or the other of the bells. Just why the inventor should prefer this arrangement to the simpler and well-known one wherein the bells are permanently connected each to its own line, and the instrument and generator are alone shifted by the switch is hard to understand, especially as the latter method not only indicates at once by the sound of the bell which line is calling, but also requires a two-pole switch instead of the four-pole switch of the patented device.

Earnings of Street Railways in New York State.

The last of the dividend-paying railroad companies operating in this State has made its report for the fiscal year ended June 30 to the New York State Railroad Commission. Three surface steam roads, which paid no dividends last year, are credited with dividends this year. In the mechanical traction and horse-propelled railroad group of dividend-paying companies there have been so many consolidations and mergers that it is not possible to make any definite comparisons. In the aggregate the dividends paid during the year recently closed, compared with the previous year, footed up:

	1901.	1902.
Surface, steam	$16,608,614	$19,679,339
Elevated	1,920,000	1,920,000
Mechanical traction	4,273,817	4,095,337
Total	$22,802,531	$25,694,676
Net increase		$2,892,145

In surface steam railroads, six of the companies increased their dividends over last year, while but one made a decrease. In the mechanical traction and horse companies, four show increased dividends and two decreased dividends. The "mechanical" roads are virtually all electrical.

Telephone Pay Stations.

Pay station service is gradually forcing its way to the front for the reason that it is appreciated by the public and is resulting in a handsome revenue to the telephone companies. A representative of one of the leading pay-station companies recently made a six months' trip for the purpose of studying the outlook, and reports very hopefully as to future business. Many companies have gone into this class of service, and wherever pay stations have been placed in a territory they are proving good investments.

Why a non-subscriber should expect free telephone service at a drug store or other public place to which he has access is just as ridiculous as a man entering a store and requesting a cake of soap gratis. Telephone officials throughout the country appreciate this fact, and are now facing the problem with a view of arriving at a satisfactory understanding regarding the advisability of eliminating this feature of "dead-head" service entirely. A company gives the service, thus increasing its operating expense, etc., without receiving in return a penny, and also slows down its service for subscribers who do contribute regularly toward the support of the company. It is advisable, it would seem, to meet this situation by a generous use of pay stations, as this is one way of securing more revenue than is possible with the ordinary flat rate, which makes it very easy for a non-subscriber to abuse the service.

The Shawinigan Power Company.

The first hydro-electric unit in the Shawinigan Power Company's power house at Shawinigan Falls, Quebec, has been started, the power being delivered in Montreal. The second unit will be started up at once and will furnish power for the operation of the plant of the Shawinigan Carbide Company, which is now nearing completion.

CURRENT NEWS AND NOTES.

BRITISH IMPERIAL CABLE LAID.—The last section of the British Imperial Pacific cable was laid at the Fiji Islands Thursday, last week, and King Edward received the first message.

ELECTRICAL ENGINEERS WANTED.—The New York State Civil Service Commission will examine candidates for the positions of electrical engineer and assistant electrical engineer. Persons desiring to enter the examinations must file their applications at the office, in Albany, before noon on November 24.

AUTOMOBILE CLUB OF AMERICA.—The annual meeting will be held November 17. The governors have nominated the following ticket: For president, A. R. Shattuck; for first vice-president, Winthrop E. Scarritt; for second vice-president, James Stillman; for third vice-president, W. K. Vanderbilt, Jr.; for treasurer, Jefferson Seligman; for three governors, to serve three years (class of 1905), Col. John Jacob Astor, Geo. F. Chamberlin, Peter Cooper Hewitt; for governor, to serve one year (class of 1903), Harlan W. Whipple.

POLYPHASE INDUCTION REGULATOR.—Whrere polyphase systems of electrical distribution are used for both lighting and power purposes, a serious difficulty encountered is that of unequal variations of electromotive force across different mains of the system, commonly known as "unbalancing," and caused in general by unequal distribution of load between different mains of the system. In some cases, moreover, as, for instance, in interconnected two-phase systems—if the loads are reactive or the transmission lines contain reactance, the electromotive forces across the two sides of the system become unequal, even if loads on the two sides of the system are equal. Two patents issued October 28 to Charles P. Steinmetz describe an arrangement for simultaneously operating upon the electromotive forces between two sides of a polyphase system, the action being such as to produce an opposite variation in the electromotive forces, either raising one and simultaneously lowering the other, or the reverse. The arrangement consists in two co-operatively arranged induction regulators, one on each side of a two-phase system. The apparatus in practice is similar in structure to an ordinary induction motor, and consists of a suitably constructed toothed ring of laminated magnetic material, within which a similarly toothed cylinder of laminated magnetic material is mounted so as to be partially rotatable. One member carries two coils, in series respectively with the two phases, while on the other member two coils in shunt respectively with the two mains are similarly mounted. The coils are so arranged that in one position of the regulator the lines of force produced by each shunt coil will all pass through or tend to pass through the corresponding series coil. The e. m. f. induced in each series coil by the action of its corresponding shunt will thus be a maximum and will accordingly add to or cut down the e. m. f. of the line a maximum amount, depending upon the direction in which the coils are connected into circuit. The coils operating upon one circuit are so connected as to have an effect opposite from that of the coils which act upon the other circuit. One set of coils thus acts to raise the electromotive force of one circuit a maximum, and to depress that of the other a maximum in the opposite direction. If now the shunt-coils be rotated or moved away from the corresponding series coils, the mutual induction between the coils becomes less, thus decreasing the boosting effect on one circuit and the lowering effect on the other. A continued relative movement of the coils finally results in bringing them into a neutral position, where no effect is produced on either circuit. A continued movement beyond this position causes a reverse action to take place, lowering the electromotive force of that circuit whose electromotive force had previously been raised and raising the electromotive force on that circuit whose electromotive force had been lowered. This provides a means for producing any desired relation between two electromotive forces without changing their mean value. The action of the device is not dependent upon the current flowing in the two branches of the system, and it does not have as its object the equalization of current flowing, thus differing essentially from many devices for balancing polyphase systems, which depend for their operation upon unequality of currents in the system.

CANADIAN NIAGARA POWER.—The International Harvester Company is erecting a large plant in Canada which will derive its power from the Cataract Power Company, Hamilton, Ont. A contract has just been closed with the Cataract Company for 3,500 electrical horse-power for this purpose.

AUTOMOBILES IN FRANCE.—According to statistics issued by the inland revenue authorities of France, the number of automobiles existing in France is 5,386, of which 2,893 are cars with accommodation for more than two passengers, and 2,493 for one or two only. Paris alone has 1,149, or about one-fifth of the total, 751 being cars for more than two persons.

BURIAL OF PROF. S. H. SHORT.—The remains of the late Prof. Short have been brought to this country and will be given interment at Woodlawn Cemetery, New York, on Tuesday next, November 11th. Services will be held at 2:30 P. M., at the Church of the Messiah, East Thirty-fourth Street and Park Avenue, to which all friends of the deceased engineer are invited. After the service, a special car will carry to Woodlawn, over the Harlem branch of the New York Central, all who desire to see the body committed to the receiving vault there.

BOOSTER REGULATION.—To obtain a nearly straight external characteristic of a booster is the object of a patent, granted October 28 to Harold Edwards. A series booster is driven by a direct-connected shunt motor and supplied with two auxiliary windings; one of these windings is in series with the motor field, and the other in series with the motor armature circuit. By these means it is stated the external characteristics becomes approximately a straight line. A similar result is claimed to be produced by a method patented on the same date, to H. F. T. Erben and A. F. Knight, according to which a series booster, driven by a belt or otherwise from a shunt motor, is supplied with an auxiliary winding connected with a source of constant potential—for example, across the mains of the distributing system including the booster.

WIRELESS TELEGRAPHY ON SOUTH AMERICAN COAST.—It is stated that the United Fruit Company has made arrangements to use the wireless telegraph system in connection with the operation of its fruit vessels in Central America. There is now no telegraphic system to or between the fruit ports of Central America. The company will establish two stations, one at Bocas del Toro, Colombia, and the other at Port Limon, Costa Rica. These are 100 miles apart. The experiments will be conducted by the company itself, under the charge of Mr. M. Musgrove, who has been laying the telephone wires for the company in Colombia and Costa Rica. The company has built 300 miles of telephone line in Costa Rica, connecting Port Limon with all the towns and stations with which the United Fruit Company does business. It will build about the same mileage in Colombia.

SIGNAL FOR ELECTRIC-CAR CROSSINGS IN LEIPZIG.—Consul B. H. Warner sends the following from Leipzig: Until a few months ago, the method in vogue in this city of avoiding accidents at crossings of electric street railways was either to station a flagman at the crossings, or to have the conductor run forward to see if the other line was clear. An automatic signal lantern has been introduced by the street railway company, which does away with these inconvenient methods. The lantern consists of two boxes, arranged one above the other, each having two sides fitted with red and the other two with green glass, the red being above the green. The cars on one line cause the incandescent lamps in the upper box to burn; the cars on the other line, the lamps in the lower one. This causes, owing to the arrangement of the glass in the boxes, a green light to appear to the first line, which indicates "free passage," and a red light to the second line, which means "stop." Signals are also visible in day time, as reflectors shut out the light of the sun, and the lantern is well lighted from the inside.

DYNAMO EXCITATION WITHOUT FIELD WINDING.—Two patents, granted October 28 to Harold W. Buck, relate to a system whereby the field winding of direct-current machines may be dispensed with. The principle consists in connecting condensers in the armature circuit in such a manner that the currents therein will be leading with respect to the impressed e. m. f., and will, therefore, have a component m. m. f. in the same direction as the required field-exciting m. m. f. In an example described, the armature is connected at three equidistant points to collector rings, which in turn are connected to the three terminals of a three-phase transformer, in the secondary of which is a condenser of the three-phase type. The number of turns of secondary in circuit with the condensers can be varied, thereby varying the capacity effect of the condenser, and consequently the field excitation and machine voltage. In construction the machine would resemble a rotary converter, one side of the armature being connected to a commutator in the usual manner and the other side tapped at regular intervals and connected to collector rings, which in turn are connected to condensers—either directly or with a transformer interposed, as above described, to enable the machine voltage to be simply regulated. With the transformer the size of the condensers may also be greatly reduced.

THE LONDON TUBE QUARREL.—A cable dispatch from London, of November 4, says: The acrimonious controversy arising from the Morgan-Yerkes "tube" rivalry was added to last evening by a statement given out for publication by George White, chairman of the London United Tramways. Mr. White characterizes as a "myth" one of the assertions in the letter from the Morgans, printed in the *Times* on Saturday, declares that another statement in the letter is "not a fact," and concludes as follows: "The facts are that after an experience of the methods of Messrs. Morgan, extending over four months and culminating in their insolent message to us through their solicitor that they absolutely declined to discuss our proposals, we determined that nothing on earth should induce us to continue business relations with that firm." The principals now seem inclined to drop the newspaper campaign. Yesterday Edgar Speyer said: "I deprecate all such press controversies. We certainly should never have appeared in print but for the harsh words of Sir Lewis McIver in the House of Commons debate, which, coming from the chairman of the tubes committee, might easily have been misunderstood. Since his letter to the *Times*, entirely exonerating my firm of any imputation of improper dealings, the matter, so far as we are concerned, is ended." Sir Lewis McIver, in the debate in the House of Commons on October 29, described the transaction of the United Tramways as "a scandal without precedent in committee work." Later he wrote to the *Times* saying he believed that the company had acted within its rights.

LETTER TO THE EDITORS.

Proposed Electrochemical Units.

To the Editors of Electrical World and Engineer:

Sirs.—I have read with much interest the account of the system of electrochemical units, proposed by Mr. Alfred H. Cowles. There is no question but that the relation he has discovered is very interesting, and the coincidence remarkable. Coincidences in physics can never be lightly treated. An instance of this is the case of the electric theory of matter which was first put forth in the ELECTRICAL WORLD in 1891. It was there shown that the tensile strength, rigidity and compressibility of the pure metals had such values as they would have if all atoms were electrically charged, and consequently the theory was put forward that all atoms were electrically charged, and that these charges were sufficient to account for all the phenomena of matter. At that time it was objected that this relation was merely a coincidence; in fact, the editorials commenting on it described it as merely a remarkable coincidence. Such was the prejudice against the idea that conducting bodies contained charges inside of them that it was not until I had further applied the theory to determine the relation between sound velocity and electric conductivity, and had discovered the rotation of the ions in a magnetic field, the relation between magnetic rotation and absorption, between electromotive force and osmotic pressure, and similar relations, that the theory finally obtained a hearing. Of its later developments it is unnecessary to speak, but at the present time it is safe to say that no physical theory is more generally accepted than the electrical theory of matter.

Having seen thus that coincidence in physics may lead to important developments in theory, it must be pointed out that care should be observed to note whether the coincidences are really physical and not merely temporal. A physical coincidence is one which holds irrespective of the date at which the experiment took place and can be

reproduced at any time. A temporal coincidence is one which depends upon the time at which the experiment is made.

Let us apply this to Mr. Cowles's proposed units. The coincidence which he discovered is based upon the relation between the amount of hydrogen in a cubic meter at atmospheric pressure and the amount of hydrogen liberated per coulomb of electricity. We can see at once that this coincidence is not a physical one for the reason that atmospheric pressure is a temporary thing. In the carboniferous age the atmospheric pressure was probably much higher than it is now. One million years from to-day the atmospheric pressure will probably be much less than it is now. Consequently, Mr. Cowles's relations must be merely coincidences and not the expression of any physical law, and cannot, therefore, serve as a proper basis of a system of units.

Nevertheless, it is a fact that Mr. Cowles's relation is an extremely convenient and fortunate one, and one adapted to greatly facilitate the labor of calculations in electrolytic work.

OLD POINT COMFORT, VA. REGINALD A. FESSENDEN.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Compensation for the Phase Shifting in Induction Motors.—OSNOS.—An illustrated article on a new method which is different from that of Goerges or of Heyland. One essential point is that he supplies the secondary part directly with current of the frequency corresponding to the slip; this can be done through a few points which are fixed with respect to the secondary part, while another set of fixed points is short-circuited. The change of the exciting current from the frequency of the network to the frequency of the slip, is accomplished automatically. Assume an ordinary two-pole direct-current machine with stationary poles and revolving armature. If the brushes are revolved, then in an external circuit connecting them there is an alternating current, the frequency of which equals the number of revolutions of the brushes, while the phase corresponds to the position of the brushes with respect to the poles. The brushes may form any angle with each other; if there are several brushes and all are revolved with the same speed, alternating currents are obtained between any two brushes, all the currents being of equal frequency, but of different phases. The mean voltage of these alternating currents depends, however, upon the speed of the armature and upon the distance between the brushes. If the machine has n pairs of poles, the frequency of the alternating current is n times the number of revolutions of the brushes. By means of the commutator and revolving brushes with a direct current dynamo, one therefore gets an alternating current, the voltage and frequency of which are entirely independent of each other. It is therefore possible to get a current of any frequency at high speeds of the field, hence with small dimensions of the machine. In the adjoining Fig. 1, let p be the primary and r

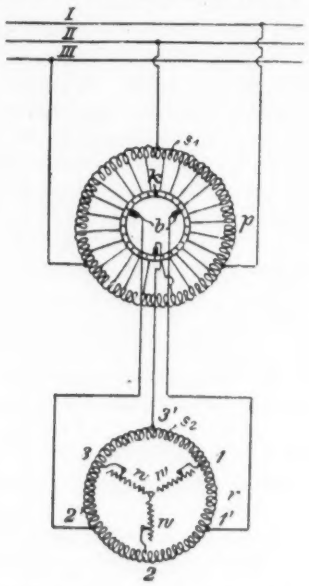


FIG. 1.—COMPENSATING FOR PHASE SHIFTING.

the secondary of a two-pole induction motor. The primary winding is connected with a direct current commutator, k, on which there are sliding three brushes which form with each other angles of 120 deg.; they are mechanically and electrically coupled with the secondary. From these brushes the exciting current is supplied to three points of the secondary. If the primary is supplied with polyphase currents, a rotary field is produced, which in its motion cuts the primary winding with synchronous speed. At any speed of the rotor the voltage between the brushes varies with a frequency which is exactly proportional to the slip. Hence at any speed frequency of the current supplied to the secondary equals the frequency of the secondary

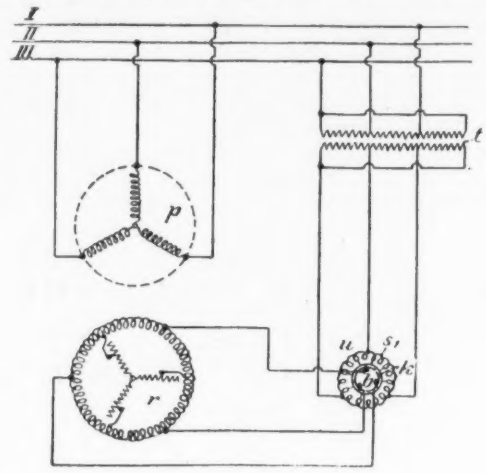


FIG. 2.—COMPENSATING FOR PHASE SHIFTING.

e. m. f., so that the principal condition for the existence of a torque at any speed is fulfilled. In order to enable the main power currents induced by the slip to combine with each other without going through the brushes, three symmetrical points, 1, 2, 3, are connected with each other by adjustable resistances, w, which serves as ordinary starting resistances when the motor is started and which are short-circuited during normal operation. These three points are situated symmetrically with respect to the three points at which the currents are introduced. He thinks that his principle may be of special advantage for the compensation of the phase difference in existing plants with a low power factor, and for large new machines in which it is desirable to avoid a special direct current winding with commutator on the machine itself. According to this principle, it is possible to take the exciting current, not from the primary, but from a separate exciting machine, n, shown in Fig. 2, which is built entirely like the primary, p, in Fig. 1. It consists of a laminated iron ring in which is embedded the direct current winding leading to the commutator. The winding, u, is connected at three points with the network, and the three brushes, b, are connected with the secondary, r. The secondary, r, and the primary, p, are made like in an ordinary induction motor. In order to reduce the voltage and the number of commutator segments, the transformer, t, is provided. Instead of using a separate transformer one may provide two windings on the exciting machine, the one with many windings being connected to the network, the other with a few windings to the commutator. As the commutator voltage of the exciting machine is proportional to the synchronous speed of the field, the strength of the latter, and hence the iron and copper required for the exciting machine, may be small, so that no more material is required than in the exciting transformer used in other methods. The mechanical coupling of the exciting machine with the induction motor can be made in different ways, one of which is shown in Fig. 3. p and and r are again the primary and secondary, respectively, of an ordinary induction motor, which is provided with slip rings, R, and start-

ing resistances, *w*. On the other side there are two other slip rings which are connected with the secondary and serve for providing the exciting current. The brushes, *b*, are at rest and transmit the exciting current to the slip rings on the right from the exciting machine, *k*, mounted on the axle, *A*, and itself provided with three slip rings,

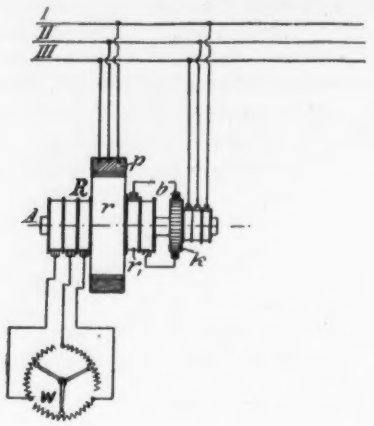


FIG. 3.—COMPENSATING FOR PHASE SHIFTING.

which are connected with the lines. If the primary is movable, the arrangement is greatly simplified, because the slip rings of the exciting machine and those on the right of the main machine, as also their brushes, become superfluous.—*Elek. Zeit.*, October 16.

Commutation.—ROTHERT.—A very long theoretical article on the theory of commutation, illustrated with numerous diagrams. His theory is based on the assumption that the breadth of a brush is exactly equal to that of a segment and that the insulation between the segments is infinitely small. As a basis for his investigation he makes the condition that the position of the brushes is assumed to be fixed and independent of the load. The formation of sparks at the commutator depends mainly on the "spark voltage," *i. e.*, upon the voltage existing at the instant when the connection between the segment and the rim of the brush is broken, and also upon the current per brush. While in the calculation of the so-called "reactance voltage," and in some theories the contact resistance between brush and segment is assumed to be constant, the author's method does not make this assumption, which, indeed, is wrong, as the contact resistance is first infinitely large and then decreases to a minimum which depends upon the conductivity of the brush, and later increases again and becomes infinitely large. He discusses by a graphical method the curve representing the current in the short-circuited coil as function of the time. With no self-induction in this coil, this curve is a straight line, while with increasing self-inducton the curve becomes more and more bent. To obtain good commutation it is necessary to get this curve as nearly as possible a straight line. This can be accomplished by three means: either by decreasing the self-induction or by increasing the brush resistance as a whole, or by using composite brushes of such a construction that the first parts of a brush have a better conductivity than the last part. For instance, he shows that if the total resistance of the brush is the same in two cases, the commutation is much poorer for a uniform brush than for a brush in which the first third has twice the specific conductivity of the two last thirds. The ideal case would be to use a brush the conductivity of which varies continually from point to point in the form of a parabola. This cannot be accomplished in practice, but he recommends to divide a brush in two or more parts of different conductivity and to choose the resistances of the different parts in such a way that their reciprocal values approximate nearly a parabola. He has not examined his conclusion experimentally, but says there cannot be any doubt concerning its exactness. He mentions, however, that the Schuckert Company uses composite brushes consisting partly of copper and partly of carbon. The fundamental differential equation of the theory of commutation is developed, and the solution is given graphically, but not analytically.—*Elek. Zeit.*, September, 25, October 2.

REFERENCE.

Voltage Drop in Polyphase Generators.—KESSELRING.—A brief article on the predetermination of the voltage drop in polyphase alternators. There are in use two different methods, the one by Rothert, based on the combination of the ampere windings in armature and field, the other by Eschenburg, based on the combination of e. m. f.'s generated by the field system and induced by self-induction. He shows that the two methods are not quite correct in principle. He points out that the ampere windings of the armature must be decomposed into two components, one for the middle point of the pole and the other for the middle point between two poles. He gives several diagrams.—*Elek. Zeit.*, October 2.

LIGHTS AND LIGHTING.

Incandescent Lamps.—WIKANDER.—A communication in which he supports the suggestion of Lummer (recently noticed in the Digest), to use incandescent lamps at higher than the "normal" voltage, as it is more economical to use three overheated lamps each of 300 hours life, instead of one normally burning lamp of 1,000 hours life. He points out that the "normal" power should be that at which the economy is a maximum, *i. e.*, when there is a certain equilibrium between the cost for lamp renewals and that of the price of the current; 10 or 15 years ago the economy was highest for 3 to 3.6 watts per candle; since that time a lamp which is operated with this power is said to be burning normally. Since that time the price of lamps has decreased to one-third or one-fifth the former price and at the same time the construction of the lamps has become better, and this shows that the highest economy will now no longer be at the same point as before. In most cases a life of 100 to 150 hours should now be more favorable than a life of 300 hours. More data are required to decide the exact point. The cost of attendants for renewals should be taken into account. He points out that if this proposal would be followed, it would be possible to allow a larger voltage drop in the network, and that would mean a cheaper network.—*Elek. Zeit.*, October 9.

POWER.

British Power Plant.—A long illustrated article on the supply system of the Midland Electric Corporation for Power Distribution. The plant has just commenced operation and is still incomplete, the works furnishing at present power to one tramway company only, but provision has been made for a large and varied load. The power house is situated nearly at the centre of the district to be supplied, and coal is very cheap there. The radius over which the company supplies power is about 7 miles. The plant contains at present two 800-kw. and one 1,500-kw. alternators, there being room for two more sets of the larger size. The alternators generate two-phase currents directly at 7,500 volts. The most interesting part of the plant is the new Ferranti switchgear, used for the first time at this plant for "extra high" voltages. It embodies the advantages of the cellular, backless and single-pole construction, and remains almost as compact as the ordinary Ferranti board for lower pressures; but in a separate editorial note the opinion is expressed that for general use it might be too expensive. The switchgear is described in detail and illustrated. It includes oil-break switches of new design and a modification of the Ferranti oil-break fuse. The switches are on the divided-break system. The main contact outside the oil container breaks circuit first, and the final break is in shunt with this, taking place at seven blades within the oil vessel, each of the blades, together with the corresponding clip contact being fixed to the interior of the vessel, constituting as it were a double-break switch, so that the spark is divided among 14 breaks in series and all under oil. In switching off, the handle while being turned to break the main contacts winds up a spring, which releases suddenly and rotates the ambroin sleeve carrying the contact blades. In switching on there is a synchronising contact at half-cock, but the break does not pass through this intermediate stage. The box containing the oil and the shunt blades is of porcelain and is entirely enclosed; the main break, which is at the back of this and therefore at the end of the compartment of the switchboard containing the switch, is also quite inaccessible until the whole piece of apparatus is withdrawn and contact is thus broken. Distribution of current to the consumers takes place in three ways: directly from the substations at 200 volts two phase; from street transformers fed at 2,700 volts from the substations and delivering at 200 volts two-phase to the consumers' networks; and from a single rotary converter substation at 500 volts direct current for tramways.—Lond. *Elec.*, October 3, 10.

REFERENCE.

Gas Engines and Waste Gases.—PERKINS.—An illustrated article on electrical stations in Germany, operated by gas engines, supplied with waste blast furnace gases.—*Elec. Rev.*, October 25.

TRACTION.

Aurora, Elgin & Chicago Railway.—A descrption of this high-speed road on which speeds of from 65 to 80 miles per hour can be made with safety. The regular speed figured upon is 65 miles per hour, with an acceleration of 2 miles per hour per second. The line is 80 miles long. Each car is equipped with four 125-hp motors. When accelerating at the rate given above, the motors require 300 amperes each. Current is taken from the third rail, placed 6 3/16 ins. above the top of the track rails and 19⅛ ins. outside the nearest track rail. The rails weigh 80 lbs. per yard, and the third T rail 100 lbs. per yard. Power is transmitted at 26,000 volts. All switching is done on the high voltage side of the step-up and step-down transformers. Full particulars are given of the transmission system. Six hundred volts are used on the trolley wire.—*St. R'y Jour.*, October 4, and *Int. Ed.*, October.

Three-Cent Fares in Detroit.—A statistical article. As Detroit is the only city in the United States where a three-cent fare is charged, particulars of the experience are of interest. The experience in Detroit indicates that low fares do not increase the traffic and gross receipts enough to compensate for the lower revenue per passenger, and that a slightly higher fare will be readily paid by passengers to a line which gives a more direct and hence a quicker service.—*St. R'y Jour.*, October 4, and *Int. Ed.*, October.

Freight and Express on Interurban Electric Railways.—LANG.—A description of the development of this feature of the interurban service, with special reference to the experienc of the Ohio companies. Schedules have been arranged on the several roads so that the freight cars are run at such hours of the day and night as not to interfere with the regular schedules of passenger cars and at the same time not to overcrowd the tracks in the freight station. This gives the service the character of an express rather than an ordinary freight system. One of the companies operates six freight trains daily, and each of the others, two trains a day. Besides these regular runs extra cars are frequently used. Regular freight cars are used on all of these roads. An interesting feature of the experience in this particular field is the fact that the small dealers in the towns within reach of Toledo make a specialty of ordering their supplies by telephone, giving instructions at the same time to ship them over the electric lines. This arrangement has the advantage of permitting the dealer to make daily requisitions upon the wholesale houses and securing delivery the same day. As the result of an exhaustive examination of the subject, the writer concludes that the value of an ordinary electric road does not depend upon its ability or capacity to carry freight or express, although its value is greatly enhanced thereby. He believes that it should develop the freight and express business as rapidly as possible, but that it should not become involved or sacrifice the regular passenger business until it is well assured that the freight will prove a profitable branch. The article is illustrated with a number of photographic reproductions, showing the class of cars used on the lines described and also the forms which are employed in the accounting departments of the several concerns.—*St. R'y Jour.*, October 4, and *Int. Ed.*, October.

Suburban Traffic Conditions of London.—DAWSON.—An article in which he first gives a table showing the area and square miles of the County of London and the City of London, with the population for the last three decades. The surface transportation facilities in the centre of the city are extremely poor, as the existing busses are neither convenient nor economical in time, and tramways are not looked upon with favor. The result is that there have been a large number of tube lines built. The writer gives a table showing the existing tube railways and tramways in London with the train miles run, miles of route and passengers carried during 1901. The effect of the tube railways and tramways has been to reduce largely the suburban business on the steam railroads, not only in London, but throughout Great Britain. This competition is being severely felt. The only salvation of the steam railroads seems to be the installation of an electric suburban service. This will be very expensive as the capital charges on the existing steam roads are now very high, but the writer sees no other course. To indicate what can be done in this respect he cites the suburban business of the London, Brighton & South Coast Railway, and gives the names of some sixteen stations, most of them within a radius of 1½ miles from the London Bridge station, with time taken by the present steam trains and average speed in miles per hour. The effect of electrical equipment on the distribution of the population in London will be very considerable, as shown by statistics quoted, which indicate a great congestion of population within the city. These people, he believes, could be so rapidly and cheaply moved between their homes and places of business by electricity that they could afford to reside from 12 to 24 miles from the city, where now they cannot go farther out than one-half that distance. The article is illustrated by maps showing the tramways, tube railways and steam railways in the city of London, and a number of smaller maps giving the routes of some of the principal London suburban steam railroad systems.—*St. R'y Jour.*, October 4, and *Int. Ed.*, October.

Boston and Worcester Electric Railway.—A description of this new electric railway connecting two important cities, about 40 miles apart in New England. Entrance into each city will be secured over the local tramway system and running time between centres of cities will be two hours; the fare will be 35 per cent. of the steam railroad fare. The rails are in 60-ft. lengths and weigh 72 lbs. per meter. Very heavy poles are used. The power will be generated in one station, and will be transmitted at 13,200 volts and 25 cycles. The generators are of the fly-wheel type. The power house is the largest in New England; full particulars are given. The substations contain 400 kilowatt rotaries. The cars are equipped with four 50-hp motors.—*St. R'y Jour.*, October 4, and *Int. Ed.*, October.

REFERENCE.

Power Houses.—KERR.—An article on the design of power plants for interurban railways and the general principles underlying it. Among the power plant features which seem to require better engineering than is now usually practiced are type and sufficiency of power house construction, feed-water purification, feed-water saving, furnace sufficiency, steam piping, protective device for electric circuits and the proper correlation of every feature with each of the others.—*St. R'y Jour.*, October 4, and *Int. Ed.*, October.

INSTALLATIONS. SYSTEMS AND APPLIANCES.

Electric Power and Light in Harbor.—LANGNER.—A long illustrated description of the electric installation in the Emden harbor in Germany. There are two 65-kw and one 135-kw direct-current dynamos, the voltage being 500; there is also a battery giving 370 amperes in one hour. For lighting, the three-wire system with 440 volts between the outers is used, the middle wire being earthed. The motors are operated at 500 volts. Power is used for the operation of five cranes and a coal conveyor. Each crane is built for a normal load of 2,500 kg, but may carry loads of 3,250 kg; each crane is operated by two series motors. The construction of the cranes and the conveyor is described and illustrated.—*Elek. Zeit.*, October 2, 9.

ELECTRO-PHYSICS AND MAGNETISM

Radioactivity.—ELSTER AND GEITEL.—An account of researches in which they investigated the fact that any conductor becomes radioactive when charged and exposed to air, especially when the air is contained in a closed subterranean space. To shed some light on the origin of this radioactivity, they have made experiments with air enclosed for three weeks in a boiler, and on air sucked up out of the ground. If the activity is due to a process within the air itself, it will be evolved in the boiler, and if it is due to contact with the earth, it will be shown in the air sucked up. The results were altogether in favor of the view that the activity of the air in a cave or cellar is due to contact with the earth and to exhalation of ground air. They now claim to have traced two distinct sources of radioactivity, one of them being the action of the sun upon the higher strata of the atmosphere, and the other being the exhalation from the soil of air which has been in intimate contact with it, and which diffuses up through capilliary passages in the ground.—*Phys. Zeit.*, September 15; abstracted in Lond. *Elec.*, October 10.

Becquerel Ray Photographs.—ELSTER.—A description of the simplest method of obtaining Becquerel radiographs. The radioactive substance is obtained by exposing negatively charged copper wires to the air, and rubbing off the surface layer after exposure. If cotton batting is used for rubbing it off, it should be moistened with a little hydrochloric acid; this is afterwards neutralized with ammonia and eliminated by igniting the cotton; the activity of the ashes is the same as that of the cotton. The radioactivity last for about five hours; as its loss is greatest at first, the exposures must be made as soon as possible. To save time it is advisable to substitute a piece of leather, moistened with ammonia, for the cotton, since it can be quickly dried in a spirit flame. The exposure is then made for about four hours, and the leather is again made radioactive. After about five such repetitions, good radiographs of lead stencils are obtained through

aluminum foil 0.1 mm. thick. The radioactivity of the exxposed wires depends, of course, to a great extent upon the weather. Air free from mist and dust is specially favorable; but the best of all is a cellar free from dust, and the author has found that the leather rubbed over charged wires suspended in a cellar exerted some visible action upon a fluorescent screen. He points out that the whole surface of the earth is practically a cathode.—*Jahrbuch f. Photographie,* 1902; abstracted in Lond. *Elec.,* October 10.

Induced Radioactivity.—SELLA.—An account of experiments in which he found that a temporary radioactivity can be imparted to a spiral spring by means of a charged rod placed in its axis and provided with needle points. The most remarkable circumstance observed was that the spring, and, indeed, any metallic body exposed to the "effluvium" from an influence machine may thus be made radioactive even if positively charged. The amount of radioactivity acquired depends largely upon the state of the atmosphere.—*Nuovo Cimento,* August; abstracted in Lond. *Elec.,* October 10.

Radioactivity of Polonium.—BEHRENDSEN.—It has been known that if pitchblende is powdered and ignited in a porcelain crucible, and the lid is kept cool, the latter is covered with a reddish-grey deposit which shows a strong radioactivity. The present author proves that this deposit consists largely of polonium. He considers it definitely established that polonium is an independent element.—*Phys. Zeit.* September 15; abstracted in Lond. *Elec.,* October 10.

Attractive Force and Magnetic Induction.—POUCHER.—A brief illustrated account of experiments in which he tested whether a formula of Kapp for the relation between the attractive force of a magnet upon its keeper, the magnetic induction and the geometrical dimensions, holds good for objects not in immediate contact with the magnet. He finds that the exact relation between the inductive and attractive force given in this formula does not hold for objects at a distance from the magnet, but so far as his observations go they bear a constant relation to each other.—*Phys. Rev.,* October.

REFERENCE.

Radium Bromide.—An article in which he gives some particulars on the properties of radium bromide and on the flame spectrum of radium.—*Phys. Zeit.,* September 15; abstracted in Lond. *Elec.,* October 10.

ELECTRO-CHEMISTRY AND BATTERIES.

E. M. F. of Ozone Cells.—BRAND.—An account of an investigation of whether the heat produced by the decomposition of ozone—which, according to Berthelet is 29,600-gram calories per 48 grams of ozone—can be utilized wholly or in part for the production of electrical energy. He found an amount of energy of 0.5 joule per coulomb The total work of ozonization amounts to 0.642 joule per coulomb, so that there is a rather high electrical efficiency. *Ann. d. Phys.,* No. 10, 1902; abstracted in Lond. *Elec.,* October 10.

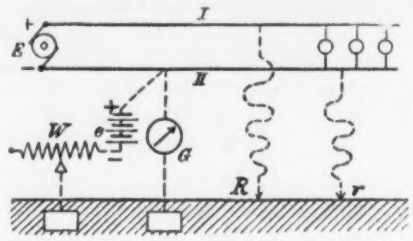
REFERENCES.

Alizarine Industry.—SIMON.—An account of a new application of electro-chemical methods. Alizarine has been manufactured from coal tar, but up to the present the methods for recovering the chromium salt contained in the mother liquor as chromium sulphate have been very troublesome. The electrolytic recovery has hitherto been hindered by the fact that no diaphragm was found that would last. This difficulty has now been overcome by Leblanc's invention of diaphragms consisting of 25 per cent. alumina and 75 per cent. silica, which not only are very durable, but also have a low resistance.—*Jahresber. Phys. Ver., Frankfurt,* 1902; abstract in Lond. *Elec.,* October 3.

Zinc.—An article giving a review of the various patented processes for the production of zinc from its ores. *Sc. Am. Sup.,* October 18.

UNITS, MEASUREMENTS AND INSTRUMENTS.

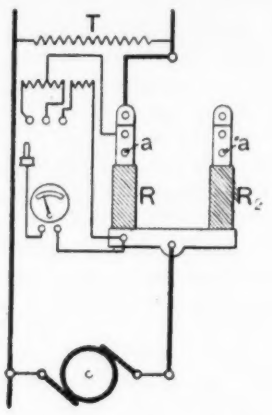
Measuring the Insulation Resistance of Direct Current Installations.—BRUGER.—An illustrated description of the following method for measuring the insulation resistance of a direct-current installation during operation. For a two-wire system the arrangement is shown in the adjoining diagram. *E* is a dynamo supplying lamps, the feeders being indicated by I and II, and their insulation resistance to earth by *R* and *r* respectively. To measure *R,* a convenient point on II is connected to the positive pole of a storage battery, *e,* while its negative pole is connected to earth through an adjustable resistance, *W.* The same point on II is also connected to one terminal of a galvanometer, *G,* the other terminal of which is connected to earth. If the variable resistance, *W,* is so adjusted that no current flows through the galvanometer, *G,* then the insulation resistance, *R,* is equal to the resistance, *W,* multiplied by the ratio of the e. m. f., *E,* of the dynamo to the e. m. f., *e,* of the battery. This latter ratio may be conveniently



MEASURING INSULATION RESISTANCE.

chosen, for instance, so that the e. m. f. of the battery is one-tenth the voltage, *E,* of the plant; then the insulation resistance, *R,* is ten times the resistance, *W.* He describes a conveniently arranged apparatus based upon this principle.—*Elek. Zeit.,* October 9.

Measuring Instruments.—FIELD.—An illustrated British Association paper, in which he describes several novelties in electrical apparatus. The first described is a "compensated voltmeter," designed for indicating at the station the voltage between either the positive or negative and the neutral main at the far end of a three-wire feeder, being compensated for the feeder drop, no matter how much or how little the network may be out of balance. This instrument has already been noticed in the Digest. He then describes a hot-wire instrument which will read amperes, volts, true watts hence power factors, giving readings consistent with one another. The drop of voltage across the instrument does not exceed 0.5 volt, so that measurements can be made by it on motors or other apparatus while connected to their normal circuits, thus no special provision for higher voltages is necessary when making such tests. The instrument is essentially for workshop and testing-room purposes, not for switchboard work. The connections of this particular instrument are those shown in the adjoin-



MEASURING INSTRUMENTS.

ing diagram. R_1 and R_2 are two alternative non-inductive resistances of different carrying capacities, either of which can be inserted in the main circuit. *T* is a potential transformer with three secondary windings giving equal voltages. A plug arrangement is attached to the instrument. The first two plug holes (from the left-hand side) give the connections necessary for the determination of watts; the third converts the instrument into a voltmeter, and the fourth or fifth, both marked *a* in the figure, into an ammeter, special calibration tables being employed. With the plug inserted in the first hole, it is practically the same arrangement as his compensated voltmeter modified for a two-wire circuit. The position with the plug in the second hole is the same, but with the secondary e. m. f. of the transformer reversed. If the instrument is calibrated to read the square of the voltage at its terminals in each case, the difference of the two readings is a measure of the watts. He then describes a fault indicator for tramway circuits; it is based on the principle of the Wheatstone bridge. Finally a new synchronizing gear is described.—Lond. *Elec.,* October 3.

REFERENCE.

Measuring the Electrical Resistance of Liquids.—DINWIDDIE.—A brief illustrated description of a very simple cell for determining the

resistance of an electrolyte by Kohlrausch's method for laboratory use by students.—*Phys. Rev.*, October.

Telegraphy, Telephony and Signals.

Magnetic Detectors in Space Telegraphy.—Wilson.—An illustrated British Association paper in which he discusses experiments made by Rutherford and himself concerning the effect of high frequency electric currents upon magnetized wires, and the use of magnetic detectors in space telegraphy over short distances. Marconi has meanwhile achieved great success over larger distances.—Lond. *Elec.*, September 26.

Miscellaneous.

Electric Response.—Bose.—An abstract of a British Association paper on "electric response in animal, vegetable and metal." The electric response is a measure of the physiological activity of the tissue, and is generally considered to be "the most general and most delicate sign of life." These response phenomena are considered to be due to some unknown superphysical "vital" force and are regulated as beyond the region of physical inquiry. The author shows that this view is not justified. He has obtained electric response in all plants and by all their organs; when the plant is killed by poison or hot water the electrical response disappears. The electric response is also present in the inorganic bodies, such as metals. The responses in plants and metals are modified by the influence of external conditions exactly in the same way as the responses of animal tissues are modified. There is not a single phenomenon in the response in muscle and nerve that has not an exact parallel in the response of metal and plants. He notices a few special cases.—Lond. *Elec.*, September 26.

New Books.

Electric Arc Lighting. By Edwin J. Houston, Ph. D., and A. E. Kennelly, Sc. D. Second Edition, Enlarged. New York: Electrical World and Engineer. 437 pages, 172 illustrations. Price, $1.00.

The second edition of this work is brought up to date by the addition of four chapters, the subjects of which are enclosed arc lamps, series alternating arc lighting from constant-current transformers, multiple-circuit arc-light generators, and photometry of the arc light. The descriptive matter, as in the other chapters, is accompanied with numerous illustrations.

Jahrbuch des Schweizerischen Elektrotechnischen Vereins. Mit einer Beilage in folioformat enthaltend die Tabellen, Statistik über Starkstromanlagen. Zurich: Jacques Bollmann.

The annual publication of the Swiss Association of Electrical Engineers has little in common with publication of similar bodies, and is also peculiar in that the greater part of the text is printed in two languages—German and French. The greater portion of the matter has reference rather to the commercial than the professional aspect of electrical industries. The first portion opens with lists of officers and members, from which we learn that there are 160 company members (members anonymes) and 280 individual members (membres effectifs). Following is the report of the proceedings of the general meeting, including reports of committees, one of which is on the Nernst lamp Among the subjects discussed at this meeting was a code of rules for electrical installation. A new federal law on the same subject was also discussed, and a petition adopted asking for certain amendments to the law.

The final portion of the volume is devoted to statistics, including a financial statement of the Swiss central station and electric railway industry A list is given of Swiss patents granted during the year, and statistics of the Swiss telegraph and telephone service

In the final pages is a directory of the professors of physics and electrical engineering at the several Swiss universities and higher technical schools; a directory of all government officials having contact with the electrical industry; a directory of electrical railways and central stations The directory is also classified by Cantons.

Statistics in great detail of the Swiss central stations are given in a folio supplement to the Jahrbuch.

Books Received.

Opere di Galileo Ferraris. Pubblicate per Cura Della Associazione Elettrotecnica Italiana. Vol. I. Milan: Ulrico Hoepli. 492 pages, 52 illustrations. Price, 12 lire.

Die Darstellung des Chroms und Seiner Verbindungen mit Hilfe des Elektrischen Stromes. Von Dr. Max Le Blanc. Halle: Wilhelm Knapp. 110 pages. Price, 6 marks.

Text Book of Chemistry. By Svante Arrhenius. Translated by John McCrae, Ph. D. New York: Longmans, Green & Co. 344 pages, 58 illustrations. Price, $2.50.

Directory of Electrical Societies, Etc.

American Institute of Electrical Engineers, Secretary, Ralph W. Pope, 95 Liberty Street, New York.

National Electrical Contractors' Association of the United States, Secretary, W. H. Morton, Utica, N. Y. Next meeting, Detroit, Mich., July 15, 1903.

National Electric Light Association, Secretary, James B. Cahoon, 136 Liberty Street, New York. Next meeting, Chicago, May, 1903.

New York Electrical Society, Secretary, G. H. Guy, 114 Liberty Street, New York.

Northwestern Electrical Association, Secretary, Thos. R. Mercein, Milwaukee, Wis.

Old-Time Telegraphers' and Historical Association, Secretary, John Brant, 195 Broadway, New York.

The Electrical Trades Society (member National Electrical Trades Association), Secretary, A. P. Eckert, 39 Cortlandt Street, New York. Board of Directors meets every second Friday of each month.

An Automatic Telephone Exchange at Westerly, R. I.

The Westerly Automatic Telephone Company, of Westerly, R. I., using the Strowger automatic telephone exchange system, under an exclusive license from the Eastern Automatic Telephone Company, of Boston, Mass., has just opened its exchange for business with its original equipment, 100 switches in use and 30 subscribers awaiting additional telephones, already ordered. The system has been so fully described in these columns that further description at this time is not needed. Suffice it to say that it is the same system now in use by the Fall River Automatic Telephone Exchange, of Fall River, Mass., that is to be used in Chicago by the Illinois Telephone and

FIG. I.—SWITCHBOARD.

Telegraph Company, and also in Columbus and Dayton, Ohio. The system is one that requires no operators at central, each subscriber to the exchange making his own connections by means of a small dial on the face of each telephone, and disconnecting by simply hanging up the receiver on its hook.

Work on construction was begun early in September, and has progressed rapidly. The capital stock of the company is $25,000, divided among about 30 stockholders, prominent local business and professional men. The company has erected its own poles, all of square-

sawed and dressed chestnut and pine, ranging from 8 in. x 8 in. to 14 in. x 14 in. The exchange occupies a room in the Champlin Block, on Main Street, in the center of the town. The rentals are $30 a year for business, and $20 a year for residences.

Power for operating the switches, busy signal and ringing is furnished by a 25-cell chloride accumulator battery of 30-amperes capacity. This is charged by a ¼-hp Holtzer-Cabot dynamo (with another

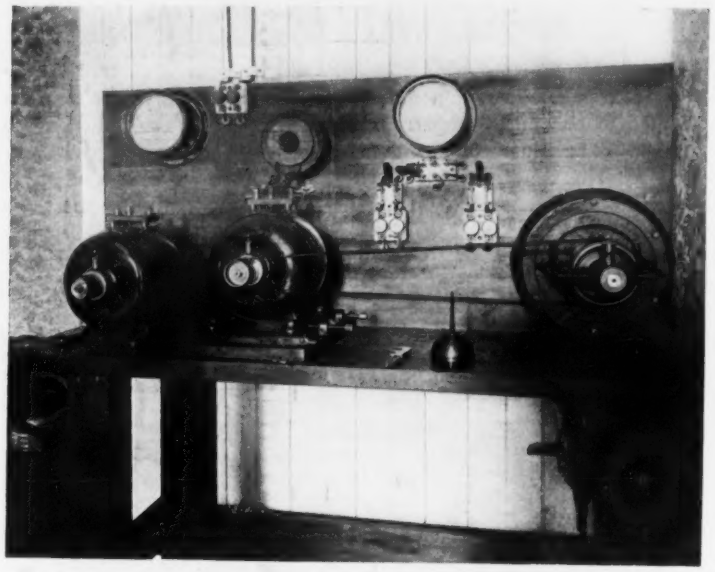


FIG. 2.—POWER BENCH.

in reserve) belted to a 2-hp "Little Giant" Belknap water motor The power bench is equipped with Whitney round-pattern ammeter and voltmeter, and the necessary jackknife switches, fuse boxes and field rheostat for the dynamos.

The distributing board is equipped with four 50-pair Sterling combined carbon plate and heat coil arresters with Standard hard-rubber cable heads, one 60-pair and five 30-pair. Six aerial dry-paper lead-covered cables, with an electrostatic capacity of less than 0.11 microfarads per mile, are used, supported by malleable cast-iron hangers from 5/16-in. galvanized steel stranded suspension wire.

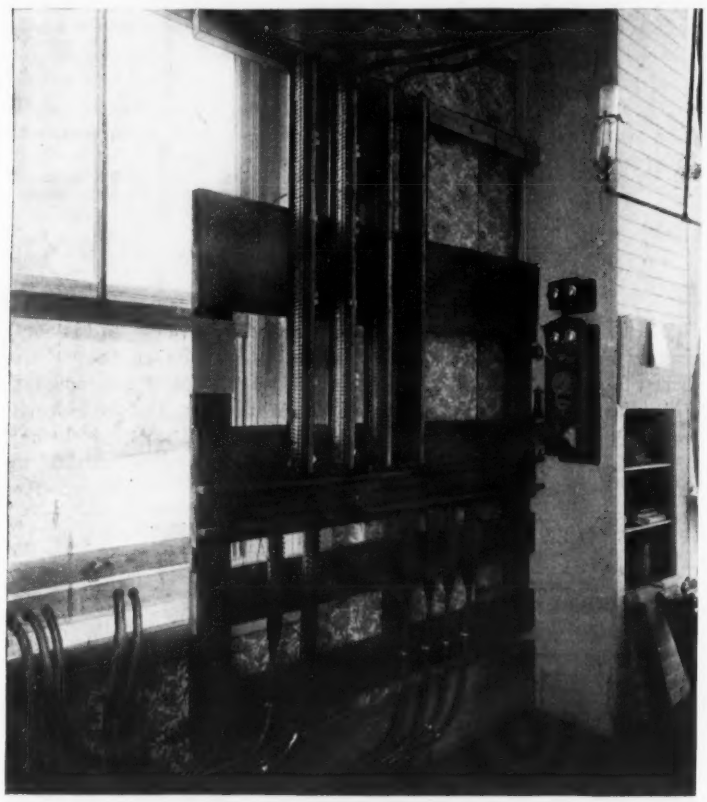
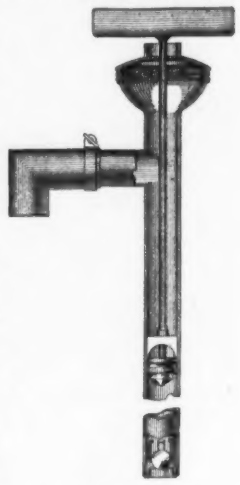


FIG. 3.—OFFICE CABLE HEADS.

The 17 cable boxes distributed throughout the town contain Sterling tubular fuse arresters. Distribution is effected from the cable boxes to the substations through twisted pairs of No. 14 and No. 16 braided rubber insulated wire. Hard-rubber cable heads are used except in a few instances where pot-heads of red-black twisted pair No. 20 wires joined directly to No. 20 cable conductors are used. At the substations the outside wires are brought in through porcelain tubes and connected with D. & W. combined tubular fuse, heat coil and carbon plate arresters. Telephones are wired to the arresters by triple-braided rubber wire. Ground wires from telephones and arresters are No. 16 single-braided rubber wire. Six-foot, 6-pin cross-arms are used, mostly with a few 10-pin arms. Pole hardware is of standard size and weight throughout, and galvanized. On cable poles a special form of galvanized iron cable seat was designed for use on the square poles. All cables, cable heads and insulated wire were furnished by the Standard Underground Cable Company.

Oil Pump.

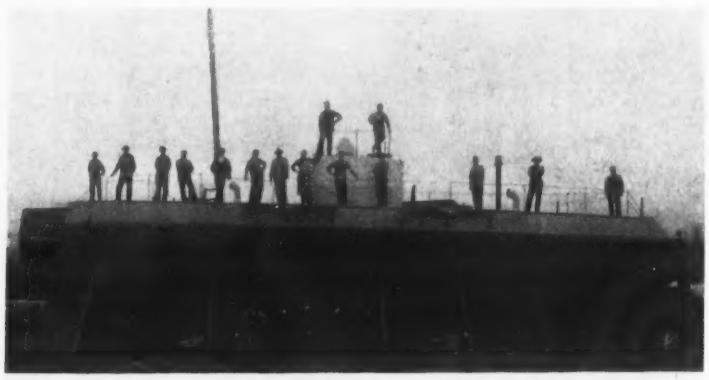
The pump illustrated herewith is provided with valves of such construction as to permit heavy oils, even when cold and stiff, to readily pass through them. The arrangement of the stuffing box is such as to prevent the oil from being carried up by the stem which carries the plunger, and spilled over the outside of the pump. In the bottom of the tube is a ball valve consisting of a seat screwed into the end of the tube and having an opening wherein is seated a ball. Vertical arms permit the ball to rise and fall without leaving the vicinity of the seat. The lower end of the valve stem consists of a plunger which has a cylindrical portion to snugly fit within the tube, an annular groove in the periphery of this portion fills with oil and serves to make a tight-working joint, the vertical portion acting merely as a guide in keeping the valve in position. The stem carries at its end a tapered block, which rests within a seat of the same taper, being also tapered on the bottom so as to form less resistance to the oil as the valve descends. The top of the tube is flared to form a head, to which a cap is engaged by means of threads, and forms a guide for the stem. Depending within this cover and surrounding the stem is a chamber composed of an annular wall and fitted with a cap, and within this chamber is a metal washer and other suitable packing material. This pump, which is made entirely of brass, is the invention of Mr. Frank O. Sterrett, and is manufactured by the Sterrett Pump Company, St. Paul, Minn.



OIL PUMP.

The New Submarine Boat "Protector."

At Bridgeport, Conn., the "Protector," the first submarine torpedo boat of the Lake type, was launched a few days ago at the works of



SUBMARINE BOAT "PROTECTOR."

the Lake Submarine Torpedo Boat Co. Miss Della Miller, of Elizabeth, N. J., daughter of President L. B. Miller, of the Singer Sewing

Machine Manufacturing Company, named the boat as she glided into the water. The "Protector" is 60 feet long, 14 feet deep, 11 feet wide, and draws 12 feet of water. She is still devoid of parts of her mechanism, although all of it is ready for installation. The company is planning to begin its preliminary trials in the Sound off this city about December 1, after which a date will be fixed for her inspection by Government officials at Washington.

Simon Lake, inventor of the boat and president of the company, said after the launching to-day that the vessel, when finished, will be capable of submergence to a depth of 150 feet, of traveling on wheels along waterbeds or in the ordinary manner on the surface. Gasoline is used for power when on the surface, and electricity while submerged. Various details have already been given in these pages as to Lake boats.

Moulding Ceiling Rosettes.

Those having to do with the installation of mill and other plants where ceiling blocks or rosettes are largely used, will appreciate the advantages of a new type which is shown in the accompanying illustrations. Fig. 1 shows in a very clear manner the construction of this rosette. The cover and its base are provided with dove-tail joints to prevent the cover from slipping sidewise, and where it is screwed home, the flexible cord terminals, inside of the cover, engage two lugs

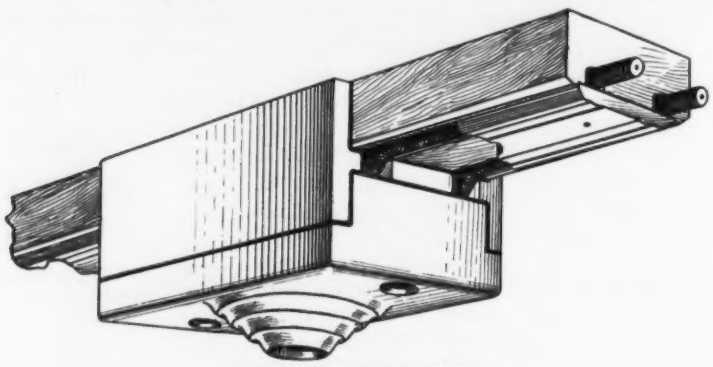


FIG. 1.—CEILING ROSETTE.

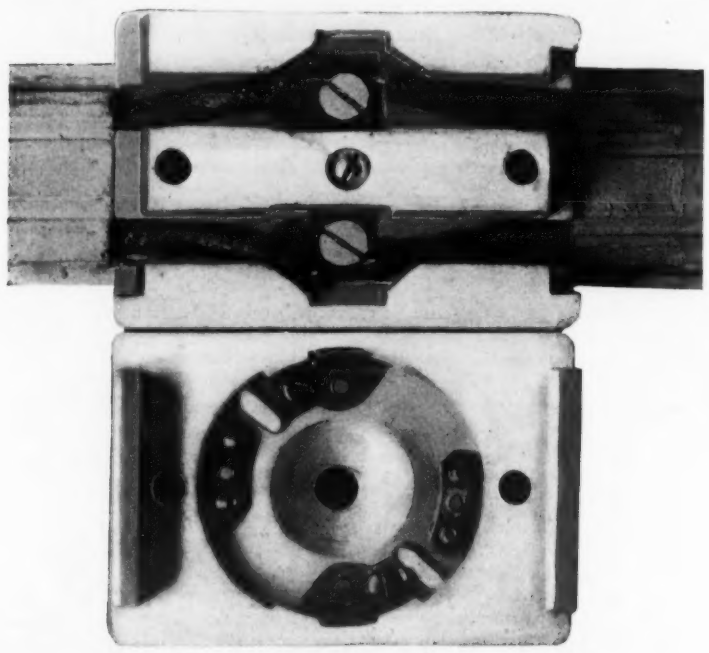


FIG. 2.—CEILING ROSETTE.

on the base, which constitute the tap terminals. In Fig. 2, which gives an interior view of the rosette, the design and combination of the various parts are plainly shown. From a moment's consideration, it is evident that it is an easy matter to add a new rosette at any time, or remove one, without marring the appearance of the main part of the moulding in any way, the porcelain base being of such a form that it straddles the same. Aside from the great saving in labor in installing by reason of the fact that the moulding need not be cut, the rosette presents a neat appearance, its shape being in conformity with the line of the moulding. This device was recently patented to Chas. Frederick Lewis, and is being placed on the market by J. Jones & Son, 64 Cortlandt Street, New York.

Cable Clip.

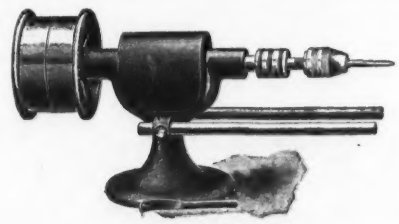
The cable clip illustrated herewith, which is manufactured by the New Haven Novelty Machine Company, New Haven, Conn., is claimed to be one of the strongest devices of its kind now on the market. The illustrations on this page show its construction very clearly. The band which encircles the cable is of zinc, and offers considerable resistance to slipping. It is brought around the cable

FIGS. 1 AND 2.—CABLE CLIP.

once and then turned back on itself, the end passing through a slit in the smaller part of the hanger and turned over to prevent its slipping loose. In applying the hanger, the zinc band is made as tight as possible, and when the end is secured, as shown, the screw is tightened, which operation brings the two steel parts of the hanger closer together. The more the screw is tightened the firmer the steel bend presses on the cable. Thus a grip is obtained that is impossible to become loosened in any other way than by releasing the screw. The two steel parts of the hanger are interlocked, as shown, so as to prevent all danger of the device coming apart.

Reverse Tapping Machine.

The horizontal bench tapping machine illustrated herewith is manufactured and being placed on the market by A. E. Faber, Jr., 355 Mulberry Street, Newark, N. J. It is designed to meet a demand for doing rapid and accurate tapping of light work, and is especially adapted to tapping holes to the bottom without breaking the taps.



TAPPING MACHINE.

The amount of work that can be done with this machine is only limited to the speed of the operator. No special taps are required, nor is a countershaft needed, as the machine is provided with tight and loose pulleys, and is intended to be belted direct to a shaft. A vise fitted to work forward and backward freely on the two parallel rods for holding the work or a jig is furnished when so ordered.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Time money was fairly active, with a good demand for the shorter periods. The closing rates were 6 per cent. for 60 to 90 days and 5½ to 6 per cent. for four, five and six months. The approaching elections, the uncertainty about the railroad labor situation and the continuance of limited supplies of time money and high rates produced extreme dullness in the stock market. Large interests were inactive and traders inclined to be bearish, but prices rallied from the early-week decline by short covering. During the latter part of the week Manhattan was a feature, advancing over 5 points on the idea that the completion of the electrical equipment of its lines will result in a further and very material improvement in the earnings of the property. The industrial stocks were rather neglected. United States Steel shares, although somewhat irregular, were not affected by a decision of the New Jersey court continuing one of the injunctions against the proposed bond issue. In the traction list, Brooklyn Rapid Transit closed at 62⅞, a net decline of ⅛; Metropolitan Street Railway, on rather limited trading, made a net gain of ¾ of a point, closing at 140¾; General Electric fluctuated between 185 and 187½, and closed at 186, a net loss of one point; Western Union lost ¾ of a point, closing at 91, and Westinghouse 5 points, the closing price being 215. Other closing quotations were: Am. Dist. Tel., 40½, a net gain of 3½ points, and Commercial Cable, 177, a net loss of 3 points. The following are the closing quotations Nov. 3:

NEW YORK.

	Oct. 28.	Nov. 3.		Oct. 28.	Nov. 3.
American Tel. & Cable..	90	90	General Electric	185	185¼
American Tel. & Tel...	163	163	Hudson River Tel.....	107	—
American Dist. Tel.....	39¼	38	Metropolitan St. Ry....	139½	140
Brooklyn Rapid Transit.	62½	62¾	N. E. Elec. Veh. Trns..	—	—
Commercial Cable	—	—	N. Y. & N. J. Tel....	—	—
Electric Boat	18½	19	N. Y. E. V. T. Co....	12	12
Electric Boat pfd.....	37	35	Tel. & Tel. Co. Am....	—	—
Electric Lead Reduc'n..	3⅝	3⅝	Western Union Tel.....	91	91¼
Electric Vehicle	4½	4½	Westinghouse Com.....	213	212
Electric Vehicle pfd.....	11	9	Westinghouse pfd.....	213	211

BOSTON.

	Oct. 28.	Nov. 3.		Oct. 28.	Nov. 3.
American Tel. & Tel..	164½	164½	Western Tel. & Tel. pfd.	99	—
Cumberland Telephone..	—	—	Mexican Telephone....	2⅛	2⅛
Edison Elec. Illum.....	270	—	New Eng. Telephone....	138¼	137½
General Electric	185½	—	Westinghouse	213	—
Western Tel. & Tel....	28½	—	Westinghouse pfd.....	213	—

PHILADELPHIA.

	Oct. 28.	Nov. 3.		Oct. 28.	Nov. 3.
American Railways.....	—	—	Phila. Traction.....	97⅞	98
Elec. Storage Battery...	85	84	Phila. Electric	8⅝	9
Elec. Storage Bat'y pfd.	—	—	Pa. Elec. Vehicle.....	—	—
Elec. Co. of America...	9⅝	9⅝	Pa. Elec. Vehicle pfd..	—	—

CHICAGO.

	Oct. 28.	Nov. 3.		Oct. 28.	Nov. 3.
Central Union Tel.....	—	—	National Carbon pfd....	100½	—
Chicago Edison.....	—	—	Northwest Elev. com...	—	—
Chicago City Ry.....	212	212	Union Traction	17¾	17¼*
Chicago Tel. Co.....	—	—	Union Traction pfd.....	47	47
National Carbon	30½*	—			

*Asked.

DETROIT LIGHTING SCHEME.—Vice-President W. F. White, of the North American Company, and Alex. Dow, manager of the Edison Illuminating Company, say that the articles in the New York papers regarding Detroit light consolidation are largely guesswork. They declare that J. Pierpont Morgan has not the slightest connection with the deal, and that the North American Company will not buy or own the Detroit plants, but is merely acting as the agent of a syndicate composed of Eastern and Detroit capitalists. The new owners will have an independent plant, not connected with or controlled by any other corporation. The present company will not even be reorganized, and there will be no changes in the board of directors. The only electric light companies in Detroit are the Edison, capitalized at $1,000,000, with 40,000 shares at $25 each, par value; the Peninsular Electric Lighting Company, capital $150,000, which is under a long lease to the Edison Company, and A. Jacobs & Co.'s small plant on the east side, capitalized at $25,000. The syndicate represented by the North American Company is buying Edison shares at $60 each, but even if every stockholder sold it would make a total of only $2,400,000. Before starting in, the North American was assured of enough stock to give control, but it was stipulated that all minority holders might come in at the figure paid for control, or $60 a share. The time expires November 1, after which minority stockholders may be sorry they did not sell, as about $2,000,000 are to be spent in developing the plant, and this means no dividends for some time. Mr. Dow says the company will have a splendid new plant, equipped with turbine engines and the very latest machinery, and will put Detroit manufacturers on as good a power basis as if they got their current from the Clergue plant at the Soo.

ALBANY & HUDSON RECEIVER AT ALBANY, N. Y.—Justice D. Cady Herrick, on motion of Sheehan & Collin, attorneys for the Colonial Trust Company, of New York, has appointed George T. Blakeslee, of Kinderhook, receiver for the Albany & Hudson Electric Railway and Power Company. This company operates the longest third-rail electric railway in the United States. The Colonial Trust Company guaranteed its bonds, and its attorneys in their petition alleged that the road is bonded for more than its true value. Damage suits are pending against the railroad as a consequence of two collisions, due to gross carelessness of the motormen, in which a large number of persons were killed and injured. Officials of the railroad say the appointment of the receiver is the first step in a plan for its complete reorganization, and that it will continue in operation. The officers of the company are: A. C. Salisbury, president; M. E. Stark, vice-president; G. C. Blakeslee, general manager.

CANADIAN ELECTRO-CHEMICAL.—It is announced from Philadelphia that under the authority of the courts and by the direction of the receiver of the American Alakli Company, an agreement has been entered into by which a 50 per cent. interest in the Canadian Electro Chemical Company, all of whose stock is owned by the American Alkali Company, is transferred to the Consolidated Lake Superior Company in settlement of the latter company's claim for $80,000. Under the same arrangement, the American Alkali Company gives up its claim against the Canadian Electric Company for advances made to it. The Consolidated Lake Superior Company will now have the manufacturing end of the Alkali concern so far as Canadian territory is concerned, and the Alkali Company is left without a plant to do any business. It is the expectation of the Consolidated Lake Superior Company to raise some $50,000 to $75,000 by a mortgage on the plant, and go on with the business.

MINNEAPOLIS GENERAL ELECTRIC.—The Minneapolis General Electric Company reports for the year ended August 31, as follows:

	1902.	1901.	Changes.
Gross	$477,153	$401,423	Inc. $75,730
Expenses	235,055	221,933	Inc. 13,122
Net	$242,097	$179,490	Inc. $62,608
Charges	97,603	100,086	Dec. 2,482
Surplus	$144,494	$79,404	Inc. $65,090

SALE OF AUTOMOBILE PLANT.—Vice-Chancellor Emery, of New Jersey, has signed an order authorizing the sale of the Hoboken plant of the American Electric Vehicle Company for $15,000 cash. The order was issued on the recommendation of Charles J. Roe, who was appointed receiver soon after the assignment of J. Herbert Ballantine, who was interested largely in the enterprise. The prospective purchaser is George T. Lister, formerly the vice-president and general manager of the concern, who says that he is acting on his own accord.

ELECTRICAL DEAL AT STAUNTON, VA.—S. D. Furguson, of Roanoke, Va., and E. M. Funkhouser, of Staunton, Va., have completed the purchase of the Staunton Street Railway, electric light and gas plants from Messrs. Sullivan and Cromwell, attorneys for the Seventh National Bank of New York, the consideration being $250,000.

DEAL AT WHATCOM, WASH.—Cyrus Pierce & Co., of Whatcom, who, together with some of their friends a month or so ago, purchased the gas plant in the city of Whatcom, Wash., have since sold out to Messrs. Stone & Webster, of Boston, who are consolidating the gas, electric lighting and street railway interests in that locality.

A WESTERN UNION PURCHASE.—The Western Union Telegraph Company has bought out the Alabama Midland Telegraph Company, whose lines reach from Montgomery, Ala., to Thomasville, Ga., along the old Plant System Railroad.

MICHIGAN TELEPHONE COMPANY'S BONDS.—Proceedings have been instituted in the United States Circuit Court at Detroit to foreclose the trust mortgage executed by the Michigan Telephone Company, March 2, 1899, to secure a bond issue of $5,000,000. The complainant is the Old Colony Trust Company, of Boston, Mass., trustee, and the cause of the suit is the telephone company's default in the payment of interest on these bonds. A feature of the bill is the averment that the acquisition of the Detroit Telephone Company's plant and franchise was without authority, knowledge or ratification of the complainant and all rights and liberties which might accrue under the transfer are disclaimed as not binding on the mortgagees.

BUFFALO BELL TELEPHONE STOCK.—A proposition to increase the capital stock of the Bell Telephone Company, of Buffalo, from $5,000,000 to $10,000,000 will be presented to the stockholders at a special meeting to be held November 15.

Commercial Intelligence.

THE WEEK IN TRADE.—Highly favorable reports continue to be received by the mercantile agencies regarding trade conditions. Confidence in the outlook for the next year's business, according to *Bradstreet's* summary, is a notable feature. The volume of orders booked for next spring's delivery is large for this season of the year, and is explained by the exceptionally good business done on fall and winter accounts, and the large crop yields of the year; also by the good condition of the winter wheat crop as cold weather approaches. Complaints are increasing as to the tardy movement of freight, miles of cars being stalled for lack of motive power and many roads refusing to accept further shipments until the blockades are relieved. The iron and steel industry, in which confidence in next year's business has heretofore been marked, shows some signs of hesitation. Finished products have tended to accumulate, apparently because of high prices. Where price reduction has occurred, however, new business has come in gratifying volumes. Strength is maintained in the cruder forms, particularly rails, bridge and structural material. The acceptance of reduced wages by tin plate mill hands enables American mills to capture orders for 1,500,000 boxes of so-called drawback plates. This will be an entirely new addition to the country's production. The copper market was extremely dull, with slowly receding prices. The demand for home consumption was small, and that for export proportionately smaller. The closing quotations are: 11.75c. @ 11.95c. for Lake; 11.60c. @ 11.70c. for electrolytic and casting stock. The business failures for the week ending October 30, as reported by *Bradstreet's*, number 194, as against 194 the previous week and 172 the corresponding week last year.

THE METROPOLITAN SWITCHBOARD CO.—It appears that the Metropolitan Switchboard Company, of No. 229 West Twenty-ninth Street, New York City, was not involved in any way by the failure of the American Union Electric Company, as reported in last issue. The Switchboard Company is a strong corporation and never has been connected with the American Union Company. The statement made by Mr. S. Marsh Young some weeks ago that the American Union Company had bought the Metropolitan Company was based upon the fact that an offer of purchase had been made to the stockholders of the Metropolitan Company, but was never accepted by them. The company is doing a large and profitable business and its shop is crowded with the best grade of work. It is building many of the largest switchboards in the city, and is now hard at it constructing the boards for the Blair Building, New York Stock Exchange, Mt. Sinai Hospital, Hall of Records, National Lead Co., Women's Hospital, St. Vincent's Retreat, Johnstone Building, etc., etc. It has recently designed a novel automobile charging board, and has installed it for Messrs. Arnold, Constable & Co., Tiffany & Co., Miss Helen Gould and the Rainier Co., New York University and others. Its work has always been of a high grade, and Mr. T. J. Murphy, the president of the company, is one of the pioneers in the switchboard business. The company has some influential and good financial backing, and there appears to be no reason why it should not continue a very decided factor in its line of work for years to come. We are indebted for the above to the well-known electrical engineer and contractor, Mr. Chas. L. Eidlitz.

EXPORTS OF ELECTRICAL MATERIAL.—The following are the exports of electrical materials and machinery from the port of New York for the week ended October 25: Antwerp—22 pkgs. material, $1,442; 2 pkgs. machinery, $500. British Australia—131 pkgs. machinery, $24,278; 56 pkgs. material, $1,779. Brussels—3 pkgs. material, $100. Bremen—3 pkgs. material, $140. British Possession in Africa—67 pkgs. material, $4,991. Brazil—54 pkgs. material, $5,670; 40 pkgs. machinery, $17,908. British East Indies—6 pkgs. material, $1,000. British West Indies—24 pkgs. material, $284; 11 pkgs. machinery, $1,625. Cuba—426 pkgs. material, $8,559. Central America—14 pkgs. material, $337. Copenhagen—2 pkgs. machinery, $325. Chili—32 pkgs. machinery, $1,588. Ecuador—1 pkg. machinery, $89. Glasgow—33 pkgs. machinery, $6,006; 17 pkgs. material, $2,105. Genoa—1 pkg. material, $25. Guernsey—1 pkg. material, $25. Gibraltar—1 pkg. material, $25. Havre—13 pkgs. material, $310; 4 pkgs. machinery, $205. Hamburg—8 pkgs. machinery, $460; 35 pkgs. material, $7,523. London—202 pkgs. machinery, $11,233; 69 pkgs. material, $3,708. Liverpool—169 pkgs. machinery, $12,603; 21 pkgs. material, $1,606. Milan—1 pkg. material, $25. Naples—2 pkgs. material, $50. Newcastle—7 pkgs. machinery, $325. Peru—2 pkgs. material, $37. Preston—2 pkgs. material, $1,143. Rotterdam—17 pkgs. material, $310. St. Petersburg—7 pkgs. material, $418. San Domingo—24 pkgs. material, $188. Southampton—40 pkgs. material, $4,832. U. S. Colombia—1 pkg. material, $13. Venezuela—48 pkgs. material, $771. Wardeau—3 pkgs. machinery, $500.

MERGER AT DALLAS, TEX.—The sale of the Dallas Ice Factory, Light and Power Company is believed to be another move towards the merging of all the electrical plants of the city and many of those in the surrounding towns and cities of Texas. The Dallas Electric Corporation just chartered in New Jersey with a capital stock of $8,500,000, is said to have absorbed the Dallas Electric Light and Power Company, the Standard Light and Power Company, the Rapid Transit Street Railway Company and the Consolidated Street Railway Company, with an ultimate intention of building a network of interurban lines within a radius of 100 miles of Dallas, which district has a population of over a million inhabitants. A Boston concern, understood to be Stone & Webster, has acquired several valuable franchises for a metropolitan street-railway system in Dallas, within the last few months, and has installed part of the system. Interurban lines are in operation between Dallas and Fort Worth, a distance of 30 miles, and between Denison and Sherman, nine miles. A representative of an Ohio corporation, which has several hundred miles of electric lines in operation in Ohio, Indiana and Michigan presented a proposition to a meeting of Sherman business men recently for the building of an electric line between Sherman and Waco, via Dallas, to cost $3,000,000. It was said that the projectors had an ultimate object of extending the road to Austin, and the construction of from ten to twenty feed lines of from 20 to 40 miles, to connect with the main, or Sherman-Austin line. The proposition is being considered by a committee of eleven.

ADDITIONAL ELECTRICAL EQUIPMENT FOR CUBAN SUGAR PLANT.—The United Fruit Company's Sugar factory at Banes, Cuba, which was recently equipped with American machinery, all electrically operated, with the exception of the crushers, at a cost of some $750,000, is reported to be about to be extended. The initial electric plant consists principally of three 100-kw generators of General Electric build, together with a number of motors, and three 160-ihp simple automatic high-speed horizontal centre crank engines turned out by the Ridgway Dynamo and Engine Company, of Ridgway, Pa. The plant was constructed by Hugh Kelly, the sugar machinery expert, of 71 Wall Street, New York. The electrical equipment was let through Percival R. Moses, the electrical engineer, 35 Nassau Street, New York. A contract for a small boiler equipment has been ordered from the A. D. Granger Company, contracting engineers, whose offices are in the White Building, 95 Liberty Street, New York. The equipment will be built at the Union Iron Works, Erie, Pa.

SEPTEMBER EXPORTS.—The export figures for September are extremely encouraging. They are the largest ever shown, with the single exception of that month in the year 1900, and fall less than a half-million dollars below the high-water mark made in that year. The figures, as just presented by the Treasury Bureau of Statistics, show the total exports in September, 1902, to be $115,521,984, against $106,989,926 in September, 1901, and $115,901,722 in September 1900, the highest figure ever shown by September exportations. This seems to indicate that the downward tendency in the export trade, caused by the corn crop failure of last year, has reached its lowest point, and that the reverse movement toward normal conditions has begun.

RENOLD CHAIN ORDERS.—Recent sales of Renold silent chain by the Link-Belt Engineering Company include: nine line-shaft drives from motors for the new works of the Patton Paint Company, Newark, N. J.; eight drives from motors to line shafts and elevators in the new model plant which the Crompton & Knowles Loom Works are erecting in Philadelphia, and eight 60-hp drives for induced draft blowers in the new Waterside station of the New York Edison Company. There are now sixety-one Renold silent chains in use in the new building of R. H. Macy & Co., varying in capacity from 1 to 90 hp.

SUSQUEHANNA RIVER POWER.—The engineers who, in the interest of the Continental Trust Company, of Baltimore, have been investigating the utility of the Susquehanna River for the development of great electric power on the Niagara plan, have reported favorably. Plans for the work have been finished, with the exception of certain details as to hydraulic engineering. It is proposed to furnish light and power to Baltimore and many towns in the northern part of the State, and also Elkton, Wilmington, Del., and other points east of the river. The Continental Trust Company, which has an option on the purchase of the United Electric and Power Company, of Baltimore, until November 15, will, it is reported, soon close the deal, involving nearly $1,000,000. A new company will likely be formed to take in this and other lighting and power companies as part of the Susquehanna power plan.

LOUISVILLE TROLLEY EXTENSIONS.—It is proposed to build an interurban trolley line between Louisville and Bardstown, a distance of about 40 miles, over a thickly settled and prosperous section. The population is much greater than for the territory served by the Louisville, Pewee Valley and Anchorage line, which has been in operation a year and is meeting with the greatest success. Another line is projected to run up the river to Prospect, about 11 miles. Still another road is projected by Louisville capitalists to run between Elizabethtown and Bowling Green, a distance of about 40 miles. The right of way has been secured. There are rich lead mines on the proposed route, fine coal deposits and a population of 20,000 people, who are 10 to 20 miles from a steam railroad. Both freight and passenger cars will be run over this line.

POWER AT THE SOO.—Advices from Philadelphia state that considerably less than half of the 60,000 hp which will be supplied by the power canal of the Consolidated Lake Superior Company has not been sold. Contracts are said to have been made by the Union Carbide Company for 20,000 hp, by the Trans St. Mary Traction Company for about 500, by the Great Lakes Paper Mill for nearly 1,500, and by a large smelting and refining company for probably 2,000 additional, making a total of 24,000 hp, leaving at present a power balance uncontracted for of 36,000. The Consolidated Company will only use the new canal themselves as a reserve, for their small power canal on the other side of the river. The officers expect in the early future to sell more power from the new canal.

BOILERS, ETC., FOR ST. PAUL POWER PLANT.—The Great Northern Railroad Company is at present letting contracts through the Robinson & Cary Company, of St. Paul, Minn., for the equipment of a central power station at St. Paul, intended to be used for operating the machinery in the company's large repair shops there and for lighting the shops. The boiler capacity will be 1,500 hp. The Edgemoor Iron Works, of Edgemoor, Del., has been awarded the contract calling for six units of 250-hp each. The coal and ash handling apparatus, capable of handling 45 tons per hour, will be built by John A. Mead & Company. The St. Paul plant has been designed so as to permit of considerable extension.

POWER DEVELOPMENT IN MAINE.—A syndicate of New York and Boston capitalists proposes to utilize the water power of Union River, at Ellsworth, Me., for the generation of electrical energy. It is thought that about 40,000 horse-power can thus be generated and transmitted to Bar Harbor and Bangor. Ellsworth manufacturers have already signed for 4,000 hp, and negotiations are in progress for the delivery of power to the Eastern Manufacturing Company, at Bangor, and other large concerns. A corporation with $1,000,000 capital has been organized. A dam will be constructed at Ellsworth, and another twelve miles above.

LIGHTING PLANT FOR CUBAN SUGAR FACTORY.—The Cape Cruz Construction Company, which is constructing an $800,000 sugar house in the vicinity of Manzanilla, located in the southeast part of Cuba, has let contracts, through O. B. Stillman, the sugar plant expert of 80-82 William Street, New York, for a lighting plant. The equipment will include two 14-in. x 12-in. horizontal Skinner engines ordered from the A. D. Granger Company, of 95 Liberty Street, New York. These engines will be each direct connected to 50-kw generators, made by the C. & C. Electric Company.

H. P. CAMERON ELECTRICAL MFG. CO., INCOR., of Ansonia, Conn., has just completed organization. It is incorporated under the laws of Connecticut with a capital of $50,000. The new company has purchased the interests of the old company, which was organized under the laws of the State of New York. It will move into a new factory, which is being erected for it, about December 1. It intends to put in a complete line of new machinery for the manufacturing of all kinds of commutators, armature coils and electrical supplies in general.

SOME C. & C. ORDERS.—The C. & C. Electric Company, 143 Liberty Street, New York, reports an increased demand locally in clothing and other manufacturing plants throughout the city. Two 50-kw. engine-type generators have been ordered for lighting purposes in the new Horn & Horn Building, Philadelphia. Huyler's candy factory in Irving Place, New York, where electricity is employed entirely as a motive power, is to be equipped with two 10-hp and one 50-hp motors, supplementing several C. & C. machines already installed.

THE BERLIN CONSTRUCTION CO., of Berlin, Conn., has opened an office in Boston, Mass., in the Board of Trade Building, 131 State Street. This office is in charge of Mr. H. C. Collins, contracting engineer, who has been for many years identified with the structural steel business in New England. The Berlin Construction Company also maintains offices at 220 Broadway, New York, and 142 Market Street, Newark, N. J.

BOOK TYPEWRITERS FOR SOUTH AFRICA.—The Elliott & Hatch Book Typewriter Company, whose New York offices are at 256 Broadway, has just secured a contract through its Cape Town agency for 300 machines, which are intended to be installed in South African municipal and railroad offices. The company reports that the sales in England during October were the largest of any month hitherto.

ELECTRIC CIGAR LIGHTERS FOR GERMAN STEAMSHIPS.—Stanley & Patterson, of 93 Liberty Street, have secured the contract for the furnishing of Matchless electric cigar lighters in all the ships of the North German Lloyd Steamship Company. The Kaiser Wilhelm II., now building in the Vulcan Shipbuilding Works, Stettin, is to be equipped with over 100 of these specialties.

NEW RIO GRANDE SHOPS are being planned for Salt Lake City, and a new power plant will be put in under the direction of Mr. R. F. Hayward, the electrical engineer. It is to furnish power for every machine in the five or six separate shops, and each tool is to be direct-motor driven. The new shops are to be equipped with tools for handling the heaviest work connected with locomotives.

ANDERSON TROLLEY MATERIAL FOR ABROAD.—The Albert & J. M. Anderson Manufacturing Company, of Boston, Mass., has just secured a contract calling for the shipment of 24 miles of trolley material to South Africa. A substantial contract has been received from South America. The company is also reported to be securing considerable orders for British roads.

CONTRACTS PENDING FOR YONKERS' SUGAR PLANT.—The Federal Sugar Refining Company, 135 Front Street, New York, will shortly let contracts for the equipment of its large plant, now under construction at Yonkers, N. Y. The initial capacity of the installation will be 4,000 hp. There will be a fair-sized electric lighting plant.

THE NIAGARA HYDRAULIC POWER & MFG. CO. has broken ground for a new power house to be located at the water's edge in the Niagara gorge. The new station will be located some distance down the stream from the present station, and it is thought that the equipment will be different from that now in use at the old station.

MUNICIPAL LIGHTING PLANT FOR FRANKFORT, N. Y.—The municipality of Frankfort, N. Y., has contracted with the A. D. Granger Company, of 95 Liberty Street, for a 200-hp steam plant to generate electricity for lighting purposes. The boiler will be built by the Union Iron Works, of Erie, Pa. The engine is to be a Corliss machine of Whitehall build.

EQUIPMENT FOR WESTERN STREET RAILWAY PLANT.—The Cleveland, Elyria and Western Railroad Company is to be furnished for installation in its new plant with four 500-hp Heine boilers. The plant is also to be equipped with a new Heine superheater, having 150 degrees of superheat. The plant is to be equipped with Westinghouse turbines.

KING EDWARD ORDERS WESTINGHOUSE PLANT.—The Westinghouse interests have secured a contract for a gas engine and dynamo equipment, which is intended to be used for charging motar car batteries at King Edward's country residence, Sandringham Hall, Norfolk, England.

WILKINSON & RICHARDSON, 276 Main Street, Poughkeepsie, N. Y., informs us that they have opened a branch of their electrical contracting business. They have an office also at Middletown, N. Y. They desire to receive a complete line of catalogues of electrical supplies.

THE STANLEY ELECTRIC MANUFACTURING CO. has recently opened a sales office in Atlanta, Ga., to take care of the increasing demand for S. K. C. apparatus in the South. The office is in the Empire Building, and is in charge of Mr. George P. Hardy.

CARS FOR CHICAGO.—An expenditure of $500,000 will be made on the Lake Street Elevated, the money to be borrowed through the Northwestern Elevated. The cost of new cars is about $350,000.

General News.

THE TELEPHONE.

SCOTTSBORO, ALA.—A company has been formed at Scottsboro to build a telephone line from Scottsboro to Tupelo, Ala.

COVINA, CALIF.—The Home Telephone Company has applied for a charter at this place.

PENSACOLA, FLA.—It is announced that the Southern Bell Telephone Company will soon begin work placing its wires underground in Pensacola.

AUGUSTA, GA.—The Southern Bell Telephone Company will build a line from Augusta to Columbia, via Johnston, S. C.

GAINESVILLE, GA.—Col. H. P. Farrow, of this place, will build a telephone line from Porter Springs to Cleveland to connect with a line, just completed, between Cleveland and Blairsville.

ATLANTA, GA.—J. A. Earl, of Atlanta, has been awarded $1,000 damages in a suit against the Bell Telephone Company for taking a telephone out of his store because he refused to pay a bill contracted by the former occupant of the store, after Earl had signed a contract with the company.

LEWISTON, IDAHO.—Articles of incorporation of the Miners' Telephone Company, with a capital stock of $45,000, have been filed. G. A. Nehrhood is president and D. W. Bailey secretary. The company will build and operate telephone and telegraph lines from Lewiston, Idaho, to Ballards Landing on Snake River, thence to Baker City, La Grande and other points in eastern Oregon and to points in the Salmon River country, Idaho.

BRYAN, ILL.—The Bryan Telephone Company has been organized, with a capital of $5,000, by G. F. Bunn, F. A. Nott and C. E. Soule.

FARMER CITY ILL.—The Farm & City Telephone Company has under construction a trunk telephone line between Clinton and Farmer City, Ill. Six wires are being put up.

JACKSONVILLE, ILL.—The Illinois Telephone Traffic Association has been organized in this city by representatives of twenty-three independent telephone companies from twelve counties of western Illinois.

PLAINVILLE, ILL.—The Adams-Pike Counties and Hannibal Telephone Company, Plainville, has been incorporated by Wm. H. Breckenridge, John W. Buttz and Chas. H. Rankin. The capital is $7,000.

CHICAGO, ILL.—The Western Telephone Construction Company, of Chicago, has been incorporated, with a capital of $2,500, to manufacture mechanical and electric devices. Incorporators: A. E. Ziehme, G. Hallett Johnson and John E. Kavanaugh.

SPRINGFIELD, ILL.—The court has refused to grant a writ of injunction against the Northwestern Telephone Company on the petition of the Chicago Telephone Company. The former company had a system in operation in Aurora, and the city council recently granted a franchise to the Northwestern Company for the construction of a second system. After it began the work of construction the Chicago company prayed an injunction in the Kane County Circuit Court to stop the work on the ground that the Northwestern's ordinance was invalid.

INDIANAPOLIS, IND.—The New Telephone Company, of this city, paid a quarterly dividend of one and one-half per cent. This is the company's first dividend.

FAIRMOUNT, IND.—The Citizens Telephone Company, of this city, has filed articles of incorporation. The capital stock is placed at $10,000, but this will be increased. The directors are Charles I. Parker, John Kesey, W. A. Beasley and Charles Small.

PADUCAH, KY.—The People's Independent Telephone Company, of this city, has closed a deal with the Alexander telephone system of 450 miles of wire and about 1,200 subscribers. The consideration was $45,000. The line covers Livingston, Lyon, Caldwell, Crittenden, Webster, Union, Hopkins, McLean and Muhlenberg Counties. By building a line twelve miles long Paducah will have direct long-distance connection with Louisville, Owensboro, Henderson and other points.

NEWTONIA, MO.—The Uneeda Telephone Company, of Newtonia, Mo., has been incorporated to build a telephone line from Granby to Newtonia, Rocky Comfort and Pioneer. The capital stock is $3,500. The incorporators are G. W. Harrison, J. W. Lansford, D. N. Dabbs, Ira Bell, J. A. Hudson, D. P. Weems, Ed Haas and others.

ST. JOSEPH, MO.—Toll lines will be built in Missouri, Kansas and Nebraska by the Central States Telegraph, Telephone and Construction Company, just organized here with a capital stock of $100,000. The independent companies in Kansas City, Leavenworth, Atchison and St. Joseph are identified with the enterprise. The principal stockholders are F. M. Baker, of Atchison, and W. F. Rankin, of Tarkio.

HAW RIVER, N. C.—Dr. Knight is building a telephone line to Oak Ridge where an exchange will be established.

NEW HOLLAND, PA.—The Enterprise Telephone & Telegraph Company has been organized at this place with a capital stock of $5,000. It will build a line from New Holland to Reading. W. M. Stauffer is president.

GLANDORF, OHIO.—Farmers in this vicinity are organizing an independent mutual telephone company.

TROY, OHIO.—The Troy Telephone Company has purchased the exchange of the St. Paris Telephone Company and the new owners will make extensive improvements.

MIAMISBURG, OHIO.—W. Wyant, of Toledo, has made application for a franchise for an independent telephone exchange. The Home Telephone Company, of Dayton, will also seek a similar grant.

TORONTO, OHIO.—The East Springfield Telephone Company has purchased from the Steubenville Phœnix Telephone Company the Richmond exchange, with franchise and toll lines in Wintersville.

COLUMBUS, OHIO.—The recent special session of the Ohio legislature cost the State $2,118 for long distance telephone bills. The service was practically unlimited for members of the legislature and the State paid all the bills.

XENIA, OHIO.—Messrs. D. and Oscar Bradfute have purchased the interests of Rankin Brothers, of South Charleston, in the Cedarville Telephone Company, of Cedarville. They expect to extend the system and thoroughly overhaul it.

DELAWARE, OHIO.—The Stromberg-Carlson Company, of Chicago, has about completed the installation of the new exchange of the Columbus Citizens' Telephone Company in this city and it is expected it will be ready for operation within a few weeks.

URBANA, OHIO.—The Urbana Telephone Company has increased its rates from $12 to $15 per year to take effect January 1. The original switchboard was designed for 500 lines, but at present the company has over 1500. It is now necessary to make numerous improvements.

MILLERSBURG, OHIO.—The Millersburg, Wooster & Orrville Telephone Company has elected officers as follows: George Adams, president; Frank L. Beam, Mt. Vernon, vice-president; B. C. Sill, secretary; J. E. Koch, treasurer, and M. M. Herron, general manager. The company contemplates making improvements to its system.

CINCINNATI, OHIO.—Many Cincinnati merchants are beginning to realize that they are losing business through lack of independent telephone connections. Local business people at Hamilton, Wilmington, Circleville and numerous other towns in that section of the State are unable to reach Cincinnati by the independent lines and their business is diverted to Columbus or Dayton.

BOWLING GREEN, OHIO.—The Bowling Green Telephone Company has passed out of existence and has been succeeded by the Wood County Telephone Company, one of the properties controlled by the Federal Telephone Company, of Cleveland. Directors are J. B. Hoge, W. L. Carey and W. B. Woodbury, Cleveland; L. Black, N. W. Morrison, F. A. Baldwin and J. G. Hickox, of Bowling Green. L. Black is president, J. B. Hoge, vice-president; W. L. Carey, secretary-treasurer; W. H. James, general manager. The new company proposes to cover a large section of the country with toll lines and farmers' systems.

CLEVELAND, OHIO.—The syndicate headed by E. L. Barber, of Wauseon, Ohio, has completed the deal for the purchase of an interest in the property of the United States Telephone Company, the Ohio long-distance company. The United States Company has $1,865,000 of stock out, all of which is owned by the Federal Telephone Company. The Barber syndicate will take 4,000 shares at 25, which will yield the Federal Company $100,000 in cash. This will be turned over to the United States Company for extensions and the United States Company will then increase its capital stock $250,000 and the new stock will be sold at once for 25, the Barber interests receiving their pro-rata with the Federal. The combined fund will be applied to make needed extensions in southern Ohio, West Virginia and Indiana. The financial changes will enable the United States Company to pay the interest on its bonds which was due July 1. The December interest will also be taken care of on time. The control of the United States Company will be lodged in a voting trust for five years. R. A. Harman and J. R. Nutt will represent the Everett-Moore syndicate or Federal Telephone Company and a third member will be selected by E. L. Barber. Work of improving the system will start at once on a large scale.

PAYSON, UTAH.—At the council meeting a franchise was granted for uniting Utah County with an electric railway and telephone system. The estimated cost of railway is about $600,000 and the telephone system $150,000.

SALT LAKE CITY, UTAH.—The Rocky Mountain Bell Telephone Company has completed its new switchboard in its exchange in this city. The board is of the most modern design and pattern. Among its features is the doing away with the storage battery click when the operator cuts in to answer a subscriber. The main board contains ten sections. There are signal lamps of four different colors, white for unlimited service calls; red for registered party lines in regular service; green for individual limited service, and blue for public stations. These colors enable the operator to determine at once which class of service is demanded when a call is made. The usual call and clearing-out signals are of white. The operators use the breat-plate transmitter. The old switchboard will be divided into sections and distributed among country exchanges.

GLOUCESTER C. H., VA.—The Tidewater Telephone Company has decided to rebuild the line from here to Saluda, using new poles and longer cross-arms and increasing the number of wires.

ELECTRIC LIGHT AND POWER.

DENVER, COL.—G. H. Sethman, W. H. Sherrod and W. F. Sperry have organized the Denver Eureka Power Company to develop water power in Middle Boulder Creek for the purpose of generating electrical energy which will be transmitted to various places.

GRIFFIN, GA.—Capt. Seaton Grantland is planning to establish an electric plant at High Falls, where it is proposed to develop between 30,000 and 40,000 horse-power. The power will be conveyed to Griffin. The estimated cost of the plant is $200,000.

BOISE, IDAHO.—Articles of incorporation of the Banville Mining Company, of Boise City, have been filed. The directors are F. R. Reed, G. F. Redway, V. B. Cutler, W. A. Davenport, W. W. Dunn and J. J. Blake. The capital stock is $300,000, of which $700 has been subscribed.

POCATELLO, IDAHO.—The delivery of power from American Falls in Pocatello was turned on a few days ago by the American Falls Power, Water & Light Company. Within the next 30 days all the smelters, factories, street lights and other enterprises will be connected and in operation.

PANA, ILL.—By the recent decision of the judge in the Christian County Circuit Court modifying the injunction granted in the case of Taylorville Electric Light vs. F. W. Anderson, restraining the city from erecting an electric light plant, it is thought that Pana will be granted a like decision. The Pana City Council some months ago voted to erect a municipal light plant at a cost of $16,000. At the instance of Robert Johns the Circuit Court issued a temporary injunction restraining the city from erecting the plant on the grounds that the indebtedness of the city would exceed the lawful limit. The contract was let to J. D. Reid, of St. Louis, who agreed to light the city for $4,000 yearly for a period of four years, at which time the city would pay him $1,000 and he would tender it the plant. At present the city of Pana is in darkness, and the people are nightly carrying lanterns.

TAYLORVILLE, ILL.—In the Circuit Court the injunction previously granted was modified by the Master in Chancery some weeks ago in the case of F. W. Anderson against the city of Taylorville. The city has been lighted for many years by the Taylorville Electric Company and its contract expired Oct. 25. The City Council a few months ago voted to issue $20,000 in bonds and to build a municipal light plant. At the instance of Anderson the Master in Chancery issued a temporary injunction restraining the city from issuing bonds, on the ground that with this additional debt the indebtedness of the city would exceed the constitutional limit. The indebtedness proven in the trial is held by the judge to be such that bonds may be issued for $16,000. As the contract for building the plant was let for $18,000 the decision amounts to a practical dissolution of the injunction, and unless other steps are taken the plant will be built immediately. Anderson is the president of the electric company and one of the largest taxpayers in the city. Until the city plant is built the city will be in darkness.

INDIANAPOLIS, IND.—The Merchants' Heat & Light Company, of this city, which recently secured a franchise, finds it exceedingly difficult to find space in the streets and alleys in which to construct its conduits. The streets and alleys of Indianapolis are completely underlaid with the pipes of three natural and one artificial gas company, the conduits of the Indianapolis Light and Power Company, the New Telephone Company, the Central Union Telephone Company and the Western Union Telegraph Company. The Merchants' Company is threatened with an injunction if it attempts to construct its conduits near any of the above, and how to conserve the rights of all has become a serious question.

ST. JOSEPH, MO.—The St. Joseph Railway, Light, Heat & Power Company has increased its capital stock from $3,500,000 to $6,000,000.

ST. LOUIS, MO.—The city council has passed the ordinance appropriating $33,000 for the establishment of an electric lighting plant in the basement of the new city hall. A similar ordinance for a lighting plant in the insane asylum was also passed. The former plant will furnish light for all the city buildings in what is known as the central district, including the Four Courts, old city hall, etc.

HELENA, MONT.—A flash from a short circuit of high tension lines set fire to the power building of the Helena Light & Power Company and the building was destroyed. Loss, $45,000; insurance, $30,000. An estimate of the loss includes the loss of the Missouri River Power Company building, which was fully insured.

NORTH AMHERST, OHIO.—The proposition to bond the town for $10,000 to build a lighting plant has passed and plans are being prepared.

CLEVELAND, OHIO.—The George S. Rider Company has made plans for a large electric power house for the W. S. Tyler Company, Cleveland.

GENOA, OHIO.—The village has placed a contract with the Toledo Motor & Machine Company, Toledo, for equipment for a municipal lighting plant. The station is to be erected at once.

DESHLER, OHIO.—The electric lighting plant in this place was offered for sale a few days ago, but was not disposed of for want of bidders. Those present claimed the appraisement of $7,000 was much too high.

DEFIANCE, OHIO.—Surveys made of the Auglaize River here indicates that it has a fall of 17½ feet, capable of affording 2,700 horse-power. The village is planning to establish a plant to furnish light and power.

TOLEDO, OHIO.—The Central Heating & Lighting Company has submitted a new proposition to the city to enter in a contract for street lighting at $58 per lamp. At present the city is paying $83 per lamp. C. S. Ashley is at the head of the new company.

CLEVELAND, OHIO.—Mr. A. Mosher, of New York, is in the city endeavoring to interest prominent capitalists in a project to equip the Ohio & Erie Canal, from Cleveland to Dresden, with electric towing equipment similar to that now being installed on the Miami & Erie Canal. It is announced that the company will soon make application to the State board of public works for a franchise to build the line.

COLUMBUS, OHIO.—The Public Service Company incorporated under the laws of West Virginia by Ohio men, has qualified with the Secretary of State. The capital stock is $500,000. The incorporators are Chas. L. Kurtz, Eli M. West, Joseph Slater, A. S. Green, W. H. Sharp, of Columbus, and R. H. Sharp, of Fairfield County. The purpose of the company is to construct and operate a plant in Columbus for the purpose of producing electric energy and furnishing electric current: producing steam and hot water, cold water and cold storage. Joseph Slater is president and A. S. Green secretary of the new enterprise.

BELLWOOD, PA.—The Citizen's Electric Light Company, of Bellwood, has been incorporated; capital, $1,000. Directors: Daniel G. Owens, John M. Hamer, Tyrone; Charles W. Hooner, of Bellwood.

PITTSBURG, PA.—The Duquesne Light and Power Company, of Pittsburg, has been chartered; capital, $20,000. Directors: G. C. Watts, H. E. Bechtel, F. H. Kreimeir, J. J. Kitner, Perry N. Gleim, Pittsburg.

YORK, PA.—One year ago a company was formed at Wrightsville, Pa., for the purpose of erecting an electric light plant. Permission was obtained from the municipal authorities for the erection of the poles and arc and incandescent lamps were ordered. Then the project became dormant. New life was given to it several weeks ago when a party of New Haven capitalists purchased a majority of the stock of the company. The councilmen were then asked to extend the time in which the plant is to be erected and the town lighted. This was granted and work on the plant which is to cost $20,000, will begin at once. The plant will be operated by water power.

PROVO, UTAH.—The City Council Committee which has been investigating the matter of water supply for the purpose of generating electric light for the city's needs has reported favorably on the project. A sufficient supply was found in various springs in Provo Cañon from which water for drinking as well as for power purposes will be obtained.

SPOKANE, WASH.—R. E. Strahon, of Spokane, has purchased the Ellis water rights near Sumpter, Oregon. It is intended to utilize the water for generating electric power for lighting at Sumpter and for other plants in and near the city. It is estimated 1,000 horse-power can be obtained.

OSHKOSH, WIS.—In the United States Court, at Milwaukee, Judge Seaman authorized A. E. Thompson, receiver for the Oshkosh Electric Light and Power Company, to issue $20,000 worth of certificates for the purpose of erecting a new power house.

CITY OF MEXICO, MEX.—Vicente Viegra, a wealthy land owner of the state of Jalisco, Mexico, is constructing a large electric light and power plant in the town of Talmazula de Gordiano, that State. The plant will be used to furnish light for the town and power for the operation of pumps for irrigating a large tract of land situated about six miles from the town.

THE ELECTRIC RAILWAY.

BATTLE CREEK, MICH.—A company headed by C. W. Post, has applied for franchises to operate railways on various streets in this city. The company offers better service than is now afforded.

PIQUA, OHIO.—The council has granted a franchise through town to the Springfield, Piqua & Sidney Traction Company. A. W. DeWeese is chief promoter of the road.

TOLEDO, OHIO.—Spitzer & Company, Toledo bankers, will undertake the financing of part of the bond issue of the proposed Detroit to Chicago interurban road which is to connect Jackson and Battle Creek.

MANSFIELD, OHIO.—The Ohio Central Traction Company has opened service on its line between Mansfield and Crestline and an hourly headway will be maintained over the entire road from Bucyrus to Mansfield.

BELLEFONTAINE, OHIO.—The Urbana, Bellefontaine & Northern Traction Company will erect a temporary power house here, so that local service can be begun in Bellefontaine by December 1. Material for the line is on the ground.

YOUNGSTOWN, OHIO.—The Youngstown & Southern Railway Company has elected officers as follows: Asa W. Jones, president; J. H. Ruhlman, secretary; W. S. Anderson, treasurer; R. L. Andrews, vice-president and general manager, and W. H. Ruhlman, right of way agent.

CINCINNATI, OHIO.—Articles of incorporation of the Traction Terminal Company, capital $100,000, have been certified. The incorporators are J. B. Foraker, Randolph Mathews, George H. Warrington and Frank H. Wilcox, of Cleveland, general counsel for the Mandelbaum syndicate.

NAPOLEON, OHIO.—The People's Rapid Transit Company has received a 25-year franchise for its line through the town. The company proposes to establish its car barns, repair shops and power house at Napoleon and it is probable that the water of the canal will be used for the generating of power.

COLUMBUS, OHIO.—It is announced that Senator J. B. Foraker has become interested in the Urbana, Mechanicsburg & Columbus Railway, and President Axline, of the company, states that it will be pushed to completion. The company has been having financial difficulties and construction work has been tied up.

OBITUARY.

EDWARD B. MALTBY, who was formerly president of the Boston Electric Light Company, died at his home in Boston, on October 30, of paralysis. He was 63 years of age. Mr. Maltby was also a director of the Boston Edison Company and held positions in various other New England enterprises.

PERSONAL.

MR. MORTON ARENDT has been appointed lecturer in electrical engineering by the trustees of Columbia University, New York City.

MR. G. R. NEWCOMER has joined the forces of the Columbia Incandescent Lamp Company, of St. Louis, and has his office and headquarters at Memphis, Tenn.

MRS. JOHN W. MACKAY and her daughter, the Princess Colonna, are to accompany the body of Mr. Mackay to this country this week. Mrs. Mackay is not expected to make a long stay.

MR. H. S. BURROUGHS has withdrawn from the firm of Ballantyne & Evans and opened an office at 27 William Street, New York, for the practice of electrical and mechanical engineering.

MR. W. MARCONI has arrived at Table Head, Sydney, Nova Scotia, on the Italian man-of-war "Carlo Alberto," and is engaged there installing new apparatus to use between that station and England.

MR. L. R. POMEROY, of the railway department of the General Electric Company, is to present a report on "Electrically Driven Shops," before the Central Railway Club, Hotel Iroquois, Buffalo, on November 14, at 2 p. m.

PRESIDENT H. H. VREELAND, of the New York Metropolitan Street Railway, denies the report that he contemplates leaving the Metropolitan Street Railway Company to take charge of the traction companies in London, controlled by Mr. Yerkes.

MR. CLARENCE MACKAY is shown in a full page portrait by *Harper's Weekly* as one of the coming men, and there is no doubt he has a great career before him in administering wisely and generously the great properties and vast wealth left by his famous father.

MR. KARL G. ROEBLING will give his bachelor dinner on the night of Tuesday week, Nov. 11, at Sherry's. Mr. Roebling is a son of Ferdinand W. Roebling, of Trenton, N. J., and his marriage with Miss Blanche Estabrook, daughter of Henry Estabrook, of Chicago, will take place a few days later.

MR. J. W. YOUNG, secretary of the Allis-Chalmers Company, whose New York offices are in the Broad Exchange Building, has been given the post of general manager of the London offices of the company. He will be succeeded in the secretaryship by Mr. J. H. Seaman, third vice-president of the company.

MESSRS. KERN DODGE and Charles Day, of the firm of Dodge & Day, modernizing engineers, have just returned from an extensive trip through the middle West where they visited many of the principal machine shops and foundries, gathering data on shop efficiency and critically comparing factory methods.

MR. GISBERT KAPP, the celebrated Anglo-German electrical engineer, physicist, journalist and good fellow is honored by the Bullock Electric Mfg. Company by having his portrait on its dainty illuminated calendar for November. The crisp biographical sketch on the back was prepared by his clever pupil now in this country, Mr. B. A. Behrend.

MR. WILLIAM SELLERS, of Philadelphia, has been nominated by the committee of the society as president of the American Society of Mechanical Engineers for the ensuing year, associated with F. H. Stillman, as treasurer; F. H. Daniels, Jas. Christie and J. R. Freeman as vice-presidents, and R. C. McKinney, S. S. Webber and H. Sanders as managers.

MR. HENRY A. EVERETT, of the Everett-Moore syndicate, Cleveland, Ohio, has resigned the presidencies of the Federal Telephone Company and the Cuyahoga Telephone Company, of Cleveland. He is succeeded in both positions by Mr. Frederick S. Dickson, of Trenton. It is stated that Mr. Everett will continue as a director in the Federal Telephone Company.

MR. R. T. E. LOZIER has been elected to the managership in the American Institute of Electrical Engineers left vacant by the election of Mr. C. F. Scott to the presidency. Mr. Lozier has not only been designated by the suffrages of his fellow members for such office, but as a committeeman has given ample pledge of his intelligent and enthusiastic devotion to the best interests of the profession and its national organization.

MR. ROBERT ROBINSON, electrical engineer of the Clyde Valley Power Company, which concern recently placed a contract valued at some $2,500,000 with the British Westinghouse Electrical & Manufacturing Company, Limited, for the equipment of two large generating stations, etc., is now visiting the United States. He was in Pittsburg in the early part of the week and intends to remain in the West for some ten days or so for the purpose of inspecting some of the larger electrical plants.

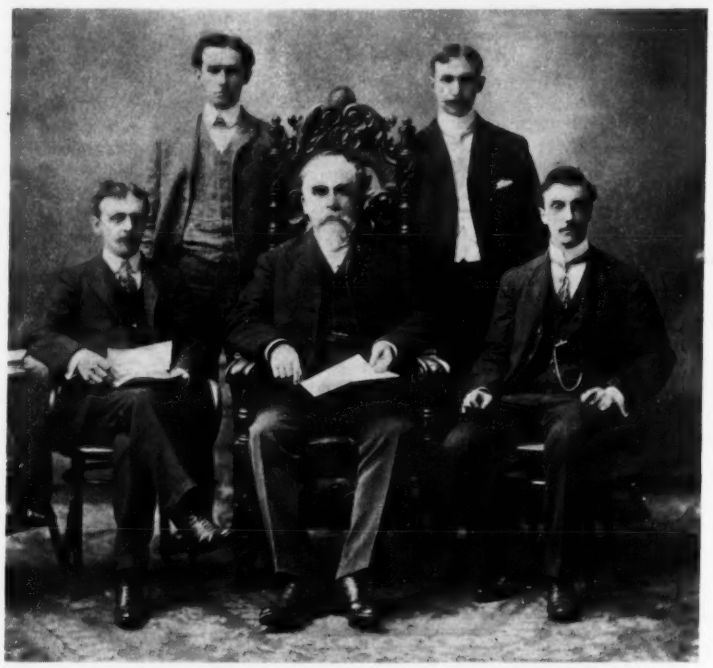
MR. GEORGE F. PORTER, who was for ten years and until quite lately secretary and treasurer of the National Electric Light Association, has become sales manager for the Atlantic Insulated Wire & Cable Company, with his offices at 120 Liberty Street. Mr. Porter is already widely known in the insulated wire industry and trade, and has a host of friends throughout the electrical field. His new duties have already begun, and there is no doubt that his devotion to work and intelligently directed efforts will succeed as heretofore.

COUNT TAEGGI, the inventor of the new electric post, has, it is stated, just left Rome for London on invitation of the British Postmaster General. Before his departure a commission appointed by the Italian government reported most favorably on his invention. All the same, Taeggi is far from confident that immediate action will be taken here. He said the other day: "If the Italian Postmaster General puts any undue delay in the way of an electric post between Rome and Naples, I shall offer to make my first experiment in the system between London and Liverpool."

MR. W. P. MACKENZIE, formerly manager of the New York offices of the Harrisburg Foundry & Machine Works, of Harrisburg, Pa., has made a copartnership arrangement with Mr. A. B. Quarrier for the purpose of acting as exclusive sales agents for the Harrisburg people in New York State as far west as Rochester, and Olean; in New Jersey as far south as Trenton, and in the entire State of Connecticut. The new firm, which is to be styled Mackenzie & Quarrier, will also act as export agents of the Harrisburg Company and proposes to handle the products of other engineering concerns in addition.

THE OFFICERS of the Rooney-Westbury Electric Lamp Company, Messrs. John Rooney, president; William H. Meadowcroft, vice-president; Harry Westbury, treasurer and sales manager; F. J. Rooney, secretary, and J. J. Rooney, general manager are represented in the accompanying group portrait. Mr. John Rooney, the president, read law in his early manhood, and was connected with a leading New York railroad law firm for over twenty-five years. Among the many business enterprises with which Mr. Rooney's name has been connected was the St. Paul Water Works; the construction of the Southern Minnesota R.R.; the Iowa Eastern R.R., and subsequently, the Erie and Atlantic and Great Western Railroads; and he was prominently identified with the Boston, Hartford and Erie R. R. Co., of which he was president for years. He was also part owner of the New York and West India Steamship Co., and its treasurer and general manager. Mr. Rooney entered the electric field in 1881, and was one of the organizers and the president of the American Electric Light Company, and one of the promoters of the Consolidated Electric Light Co., and the Sawyer-Man Electric Company, all of which were subsequently merged into the Westinghouse Electric Manufacturing Company.

Mr. William H. Meadowcroft, vice-president, also started on a legal career, having been admitted to the New York Bar in May, 1881. Major Easton, of the law firm with which Mr. Meadowcroft was connected, having accepted the vice-presidency of the Edison Light Company, Mr. Meadowcroft left the legal profession and became identified with the Edison company and continued his association with the same and its successors over eighteen years, two years being spent in the legal department. During the last years of his association with the General Electric Company he devoted his entire time to the miniature and decorative lamp business, a branch of the lamp department which he originally started in 1885; and he took part in the development of the Röntgen ray business of the company from its commencement. In the early 80's he took an active part in the Edison Electric Illuminating Company, the Edison European Company and the Edison Ore Milling Company, as well as with various standardizing and technical committees that were organized in those days for operating part of the business. He also wrote the first commercial pamphlet on incandescent electric lighting that was published in this country, and prepared all the catalogues for the Edison Companies in 1884, as well as a number of booklets that were published in 1887 and 1889, and some other special catalogues in later years. Mr. Meadowcroft has also done some other writing in his leisure moments, such as, for instance, his popular manual "A B C of Electricity," of which over 76,000 copies have been sold. In the summer of 1899 Mr. Meadowcroft left the General Electric Company to go into the storage battery business, and the Perret Storage Battery Company was organized, with a factory in Brooklyn and an office in New York. After considerable preliminary work had been done and by the time that the battery was ready to put on the market, the president and financial member of the company, Mr. Theodore Berbell, unexpectedly died, and Mr. Perret was taken seriously ill. It was therefore deemed advisable to suspend for a time the operations of the Perret Company. Mr.



THE MESSRS. ROONEY, MR. MEADOWCROFT AND MR. WESTBURY.

Meadowcroft having some financial interests in the National Bread Company and the United States Bread Company, and being a director in both, accepted the position of treasurer of both these companies and still occupies the same official relations. His love of the old business of decorative and miniature incandescent lamps has prompted his joining forces with Messrs. Rooney and Westbury.

Mr. Harry Westbury, the treasurer and sales manager of the company, graduated from one of the largest colleges in the west of England, and for some years held a position as head accountant and afterwards as salesman in the brass foundry business. On coming to this country he entered the employ of the General Electric Company, at Harrison, N. J., and was associated with Mr. W. H. Meadowcroft in developing and increasing the sales and uses of the miniature lamp and after that gentleman resigned his position in 1899 conducted the commercial end until he recently resigned to enter the above company. His name has been intimately associated with the developments in Röntgen ray work for several years past and is well known in scientific circles, both in this country and Europe, as an expert on Röntgen tubes, etc.

Mr. Francis J. Rooney, the secretary of the company, is a mechanical engineer and a graduate of the Polytechnic Institute of Brooklyn. He was for over two years assistant manager of a large manufacturing business in New York City and subsequently superintendent of an electro-therapeutic establishment, and private secretary to his father up to the organization of this company.

Mr. John J. Rooney, the general manager of the company, is a graduate of the Polytechnic Institute of Brooklyn, being one of the first students to take the electrical engineering course established in 1893 by Dr. Samuel Sheldon. He early devoted himself to storage battery work and perfected a new type which, however, he did not place on the market owing to the patent situation. He then turned his attention to high tension electro-therapeutic work and recently installed a large plant of this character in London.

Trade Notes.

THE MAXWELL M. MAYER ELECTRIC COMPANY, 216 Centre St., New York, has just issued Bulletin No. 113, giving general specifications of its line of direct-current motors and dynamos of the enclosed type. A list of some of the users of these machines is given.

THE MARINE ENGINE & MACHINE COMPANY, 80 Broadway, New York, has increased its capital stock and has purchased the real estate and buildings comprising its plant in Harrison, N. J. Mr. E. C. Benedict is president of the company and J. B. M. Showell, secretary.

SIGHT FEED LUBRICATOR.—The Lunkenheimer Company, Cincinnati, Ohio, reports that it is receiving some very flattering testimonials in reference to its graphite sight-feed lubricator. The company prints a circular describing and illustrating this device, and a copy of it may be obtained on application.

STOREY MOTORS.—The Storey Motor & Electric Company, Harrison, N. J., has recently issued a catalogue describing and illustrating its well known enclosed and dust and moisture proof machines. Illustrations show the machine in section and various applications, and diagrams and tables give the dimensions of the various sizes.

MINIATURE LAMPS.—The Jaeger Miniature Lamp Manufacturing Company, Fourth Avenue and Eighth Street New York City, has issued a catalogue illustrating and briefly pointing out the features of its extensive line of miniature lamps. These lamps are used for a great variety of purposes including telephone, dentistry, surgery and decoration.

ELECTRIC LABORATORY FURNACES.—Eimer & Amend, 205 Third Ave., New York, have issued a well-illustrated catalogue of electric furnaces, which includes also illustrated descriptions of an electric pyrometer and an electric heating apparatus for distilling ether. Five types of electric furnaces are shown, namely, two for crucibles, a muffle, a sectional combustion and a Moissan type.

THE ELECTRIC APPLIANCE CO., Chicago, is advising the sale of arc lamps to merchants for store lighting. It claims that this is the season when store advertising pays and that a merchant cannot advertise to better advantage than to have a well lighted and therefore attractive store. In this connection, it states that there is one arc lamp a little better than all others, namely the Adams-Bagnall.

MESSRS. CROSELMIRE & ACKOR, 42 Walnut St., Newark, N. J., platinum refiners are just closing their first year in business with excellent results. They have been compelled to enlarge their plant several times and at present they have facilities for filling all orders promptly. The New York office is at Forty-second St. and Sixth Ave. (Harvard Building) for the convenience of metropolitan customers.

THE BUFFALO FORGE COMPANY, Buffalo, N. Y., has recently issued two new pamphlets on the subject of the Buffalo engines and this company's system of mechanical induced draft. In the former bulletin the features of a typical engine are given, which are followed by illustrations of engines of various types manufactured by the company. The pamphlet on induced draft is gotten up on the same plan.

THE NILES TOOL WORKS COMPANY, Hamilton, Ohio, is planning to erect a large addition to its plant, which, it is claimed, will make it the largest of its kind in the country. The total floor space in the new structure will be 85,000 square feet. The erection of the proposed addition is, however, contingent upon the company securing larger foundry facilities. The present foundry is taxed to its full capacity.

SECOND-HAND MACHINERY.—Wickes Bros. machinery manufacturers and dealers in second-hand machinery, Saginaw, Mich., have a very full line of machines and apparatus of various kinds all ready for immediate delivery. The October list contains 34 pages of closely-printed matter and gives dimensions, etc., of the stock of new and second-hand machinery on hand. The firm handles boilers, engines, machine tools, etc.

THE STERLING ELECTRICAL MFG. CO., Warren, Ohio, which recently distributed among its many friends a souvenir in the shape of an ash tray for a business man's desk has excelled its generosity in producing a new souvenir. This is a reproduction in bas-relief of the celebrated painting "Diana's Chase," by Makart. It is a highly ornamental production of the picture now hanging in the Metropolitan Art Museum, New York City.

THE GREEN TRAVELING LINK GRATE is the subject of the well illustrated catalogue just issued by the Green Engineering Company, Chicago, Ill. This make of grate is well illustrated and several half-tone cuts give views of plants in which they have been installed. Illustrations also show the details of the grate. At the back is given some tabulated information about coal in Illinois, Pennsylvania and Ohio, giving analyses, heat value, etc.

THE "EXPRESS."—In a small pamphlet under the title "The 'Express' and Some of its Stopping Places," the Kellogg Switchboard & Supply Company, Chicago, gives copies of 51 testimonial letters received from as many users of these boards. Judging from these letters the boards are giving the best of satisfaction. The "Express" boards are made for small exchanges of 50 to 500 lines. They are simple, rapid and easy to operate, and many hundreds of them have been sold.

THE VAN DORN-ELLIOTT ELECTRIC COMPANY, Cleveland, Ohio, has greatly increased its facilities for making armature and field coils. This department of the business heretofore has not been able to meet the demands upon it, and its enlargement was necessary in order to enable the company to get out the work with greater promptness. Mr. J. Norman Elliott has been appointed general superintendent of the factory, Mr. J. T. Thompson being foreman of the winding department.

THE AMSTUTZ-OSBORN COMPANY, of Cleveland, Ohio, has been succeeded by the Osborn-Morgan Company, P. J. Morgan having bought out the interest in the concern formerly held by N. S. Amstutz. The company has just opened a new factory at the corner of Case Avenue and Kelly Street, where it will carry on a general manufacturing business, giving especial attention to the production of several new patterns of arc lamps which it has recently perfected. The new factory is 120x60 feet, very light and well equipped for the production of these goods.

VENTILATING FANS.—The Western Electric Company has just issued a catalogue of its line of ventilating fans for removing heat, dust, moisture, steam and impure air from engine or dynamo rooms, kitchens, restaurants, laundries, churches, schools, theatres, mills, mines or cold storage rooms. For pressure work, hot and cold air ventilated systems, the company supplies steel plate blowers direct driven by its motors. Various illustrations show the application of the Western Electric motor to different styles of fans. Two pages are devoted to illustrations and brief descriptions of motor speed-controllers.

PACKARD'S "ELECTRICAL ARENA."—This is the title of a pamphlet recently issued by the New York & Ohio Company. It is a strange combination of stage and "Packard" lamps, and the plot is cleverly developed. This "allegorical phantasmagoria entitled Thunder and Lightning," is written up in the language of the stage and in proper dramatic form, and is illustrated with various characters in the play. The Packard lamp triumphs over the competitive lamp, which is represented by the "villain" in the plot. Mr. A. H. Mustard, 120 Liberty Street, is the author of this tragedy, and incidentally the New York representative of the Packard lamp.

THE WISCONSIN GRAPHITE COMPANY, Pittsburg, Pa., has just issued a booklet giving information about Wisconsin flake graphite which is commended for its high lubricating properties. It is stated to be particularly serviceable for electric plants, for high-speed engines and machinery and for steamship and other powerful engines. The company also manufactures a graphite paint, which is the subject of another pamphlet. This paint is recommended for use on iron and steel structures particularly where exposed to the weather. It is made in various colors. The cover of the pamphlet on flake graphite is shaped to represent a can in which this substance is packed. Copies of these booklets may be obtained by addressing the company, and those concerned in lubrication and paints will no doubt find something of interest in both of these publications.

THE ROONEY-WESTBURY ELECTRIC LAMP CO, of 154 E. 23d St., New York has been incorporated to manufacture all kinds of miniature incandescent lamps and accessories. There are at the present time upwards of 7,000 varieties of miniature lamps and this number is continually being added to, as more and more fields of usefulness and ornament are being found for them. The manufacture of the miniature lamp is one requiring the most delicate care and attention, as while the large standard lamp is now more or less made by machinery, the miniature on the contrary is still almost entirely a handmade product demanding the most expert labor and skill in glass blowing, etc., that can be obtained. The above-named company has a number of novelties it intends placing on the market which should commend themselves to the users of miniature lamps. One is a double filament battery lamp on which a patent has not been granted, so arranged that it can be burned with both filaments at once or one at a time, as preferred, thus giving either double brilliancy or double life. Another is a special form of miniature reflector lamp with a silvered bull's eye more than doubling the candle power for the same expenditure of current. Several ingenious novelties in automobile lamps with reflectors should commend themselves to automobile users.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED OCTOBER 28, 1902.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

711,941. SUBMARINE CABLE TELEGRAPH; A. C. Crehore, Hanover, N. H. App. filed Nov. 3, 1898. Relates mainly to the manner of distinguishing the various characters of any code from one another by a combination of the elements of time, polarity and difference of electro-motive force applied to the circuit.

711,942. TELEGRAPHY; A. C. Crehore, Tarrytown, N. Y. App. filed Oct. 21, 1901. In a quadruplex telegraph apparatus, continuous current and pulsatory current apparatus for the two sides of the double transmission at each station, balancing branches for both sides of the system, ground branches or connections from which said balancing branches are derived and an inductance in the ground branch or connection for the continuous current side.

711,943. TELEGRAPHY; A. C. Crehore, Tarrytown, N. Y. App. filed March 8, 1902. An object is to permit two separate parties each on a single Morse wire, to communicate independently with distant stations over a single main-line wire operated as a superposed telegraph circuit by the use of suitable repeating apparatus.

711,944. ELECTRIC CLOCK; C. M. Crook, Bristol, Conn. App. filed Sept. 30, 1901. Details.

711,973. SIGNALING AND SWITCHBOARD APPARATUS FOR TELEPHONE-EXCHANGE CIRCUITS. D. S. Hulfish, Chicago, Ill. App. filed November 5, 1901. (See page 751.)

711,974. SOUND CONCENTRATOR; C. L. Hyde, Tuxedo Park, N. J. App. filed December 12, 1901. (See page 751.)

711,997. PROCESS OF FORMING ELECTRIC ACCUMULATORS; W. Morrison, Chicago, Ill. App. filed March 18, 1901. Current is passed

through a solution containing fluorine with the chlorates and nitrates or other oxidizing compounds.

712,026. ELECTRIC OR AUTOMATIC SWITCH THROWING MECHANISM; J. M. Walker, Newcastle, Pa. App. filed Feb. 25, 1902. Details.

712,041. EXCITING-DYNAMO; Harold W. Buck, Schenectady, New York. App. filed September 2, 1898. (See Current News and Notes.)

712,045. PROCESS OF CONVERTING SALT MARSH MATERIAL, ETC., INTO A FERTILIZER AND THE PRODUCE RESULTING THEREFROM; J. J. Crooke, New York, N. Y. App. filed Feb. 21, 1902. The process consists in subjecting the material to electrolysis.

712,046. MEANS FOR ATTACHING COMMUTATOR LEADS; W. F. Dawson, Schenectady, N. Y. App. filed April 27, 1901. The commutator bar has fitted to one end, before assembling, a flat copper tube, into the end of which the lead is soldered after the commutator is mounted on the machine.

712,050. SYSTEM OF ELECTRICAL DISTRIBUTION; Harold Edwards, Schenectady, N. Y. App. filed March 30, 1901. (See Current News and Notes.)

712,052. SYSTEM OF ELECTRICAL DISTRIBUTION; Hermann F. T. Erben and Arthur F. Knight, Schenectady, N. Y. App. filed April 3, 1901. (See Current News and Notes.)

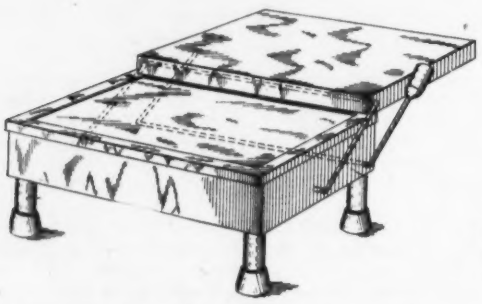
712,056. MICROPHONE FOR HIGH TENSION CURRENTS; R. G. E. Ducretet, Paris, France. App. filed March 3, 1902. (See page 751.)

712,057. DENTIST'S ELECTRICAL ANNEALING FURNACE; N. K. Garhart, Indianapolis, Ind. App. filed Aug. 22, 1902. The furnace has a flat heating surface and a similar cover connected to the main body by parallel links, whereby it may be swung aside and maintained horizontal to temporarily receive articles undergoing treatment.

712,060. OVERHEAD ELECTRIC CONDUCTOR, OVERHEAD TELEPHONE, TELEGRAPH, OR LIKE WIRE; R. Hacking, West Bridgeford, England. App. filed Feb. 26, 1901. Details.

712,063. ANTICREEPING DEVICE FOR ELECTRIC METERS; C. D. Haskins, Schenectady, N. Y. App. filed March 30, 1901. Mechanical means for preventing creeping of the rotating member of the meter, arranged to alternately retard and accelerate said member when the meter is in operation.

712,090. ELECTRIC METER; W. H. Pratt, Lynn, Mass. App. filed March 15, 1901. Means for opening the circuit of the actuating motor through a step by step gradation of resistance, when the speed of the motor approximates proportionally with the quantity to be measured.



712,057.—Dentist's Electrical Annealing Furnace.

712,103. POLYPHASE INDUCTION-REGULATOR; C. P. Steinmetz, Schenectady, N. Y. App. filed February 27, 1899. (See Current News and Notes.)

712,104. SYSTEM OF ELECTRICAL DISTRIBUTION; Charles P. Steinmetz, Schenectady, N. Y. App. filed July 11, 1900. A synchronous motor driving a rectifier having in circuit a constant-current transformer, is started from the constant-potential mains and then switched on the constant-current circuit. The claims are on the method.

712,106. ELECTRIC METER; E. Thomson, Swampscott, Mass. App. filed Oct. 13, 1898. When the speed of the motor exceeds a certain point with respect to the current flowing, the motor circuit is opened by a fan driven by the motor.

712,107. THERMAL CUT OUT; M. O. Troy, Lynn, Mass. App. filed Dec. 11, 1899. A fuse wire encased in a tube, closed at one end and open at the other, the weak point of the fuse located near the closed end of the tube.

712, 131. INSULATED RAIL JOINT; G. L. Hall, Brooklyn, N. Y. App. filed Jan. 18, 1902. Fish-plates are flanged laterally at the joint and secured together with insulation between.

712,132. INSULATED RAIL JOINT; G. L. Hall, Brooklyn, N. Y. App. filed Feb. 12, 1902. A modification of the preceding patent.

712, 134. ELECTRIC TIME SWITCH; M. R. Hutchison, Upper Montclair, N. J. App. filed Nov. 22, 1901. A reversible closed chamber containing a body of mercury which flows from one end to the other at a rate determined by the angle of inclination, said angle being adjusted by a scale so that in either charging or discharging a storage battery, the number of ampere-hours will be the same.

712,149. ELECTRIC LAMP SOCKET; H. T. Paiste, Philadelphia, Pa. App. filed April 6, 1901. A multi-filament lamp with a switch for throwing the filament successively into circuit.

712,153. METHOD OF AND APPARATUS FOR ELECTRODEPOSITION OF METALS; C. J. Reed, Philadelphia, Pa. App. filed Aug. 1, 1901. An electrolytic apparatus comprising a mixture of a liquid electrolyte and a non-conducting granular substance, and two electrodes, one of which receives the metallic deposit and is movable in the mixture, for the purpose of producing a uniform plating which does not require polishing.

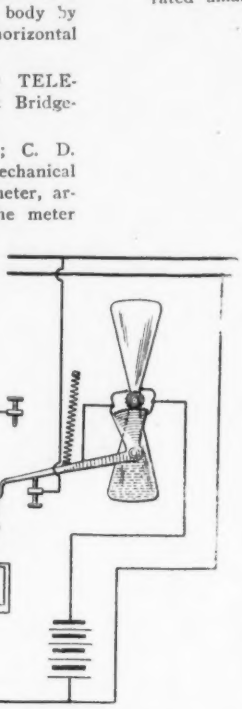
712,174. SYNCHRONISM INDICATOR; J. F. Begole, St. Louis, Mo. App. filed June 9, 1902. In a synchronism-indicator, two sources of alternating current, a voltage indicator energized from said sources, and a phase indicator comprising two coils, one of which is movable relative to the other, one of said coils being supplied with current from one of said sources and the other of said coils being supplied with current from the other of said sources.

712,178. SEPARATOR FOR STORAGE BATTERY PLATES; R. N. Chamberlain, Depew, N. Y. App. filed May 13, 1901. A perforated box-like inclosure having internal and external ribs.

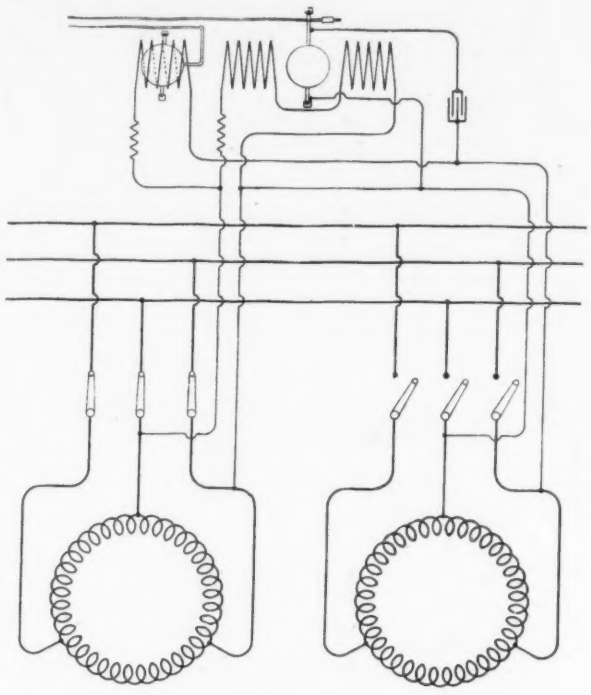
712,201. SIGNAL FOR TRAVELING CABLES; M. Norden, New York, N. Y. App. filed Nov. 23, 1901. A circuit is closed by a broken strand of the cable in passing a given point.

712,204. AUTOMATIC SWITCH FOR FUSE WIRES IN ELECTRIC CIRCUITS; E. W. Pelton, Springfield, Mass. App. filed Nov. 30, 1901. An arm normally under tension is restrained by the fusible strip; when the latter breaks, the arm closes a circuit through the next fuse of the series.

712,218. ELECTROLYTIC CELL; A. E. Truesdell, Pittsfield, Mass. App. filed April 13, 1901. The cell is adapted for the treatment of solution containing the salts of the alkaline metals. The object is to provide for a positive separation of the amalgam from the cathode body, to provide for the smallest possible area of contact between the amalgam and the solution and to introduce a recharged solution at or near the point of contact of the separated amalgam with the solution. (See page 750.)



712,134.—Electric Time Switch.



712,174.—Synchronism Indicator.

712,220. AUTOMATIC MEDICAL ELECTRICAL APPARATUS; A. F. Vetter and J. C. Vetter, New York, N. Y. App. filed Feb. 26, 1901. The electrode through which the current is applied to the body is made of various materials to obtain difference of electrical resistances.

712,257. ARMATURE FOR DYNAMO ELECTRIC MACHINES; J. Burke, Berlin, Germany. App filed Jan. 6, 1900. An armature having means for magnetically saturating the teeth when the coils adjacent thereto are in the commutation zone.

712,316. ELECTRIC ACCUMULATOR; F. Loppe, H. Morin, G. J. A. Griner, and D. P. Martin, Paris, France. App. filed Oct. 26, 1899. Details.

712,333. ELECTRIC RAILWAY SIGNAL; C. V. Richey, Washington, D. C. App. filed April 8, 1902. Details.

712,402. TELEGRAPH ATTACHMENT; G. T. Newman, Bonaparte, Iowa. App. filed Sept. 6, 1901. (See page 751.)

712,430. RAILWAY SIGNAL; G. L. Wilson, Chicago, Ill. App. filed Sept. 16, 1901. A colored slide on the signal arm is moved along the arm by the pull exerted on a connecting wire, by the train.

712,440. INSULATOR; J. L. Shreffler, Lewistown, Pa. App. filed April 2, 1902. Two metallic shells, one embedded within the other in insulating material and the outer shell having a clamp for the wire.

712,451. EXCITING-DYNAMO; H. W. Buck, Niagara Falls, N. Y. App. filed September 2, 1898. (See Current News and Notes.)

712,455. BUSY-TEST SYSTEM; David H. Hulfish, Chicago, Ill. App. filed November 5, 1901. (See page 751.)

712,463. POLYPHASE INDUCTION-REGULATOR; C. P. Steinmetz, Schenectady, New York. App. filed Feb. 27, 1899. (See Current News and Notes.)

712,464. SYSTEM OF ELECTRICAL DISTRIBUTION; Charles P. Steinmetz, Schenectady, N. Y. App. filed July 11, 1900. A synchronous motor driving a rectifier having in circuit a constant-current transformer, is started from the constant-potential mains and then switched on the constant-current circuit. The claims are on the combination of a motor and circuits to accomplish this object.